Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

Report

National Brucellosis Technical Commission

R. K. Anderson
David T. Berman
W. T. Berry
John A. Hopkin
Robert Wise

APPENDIX C

Social and Cultural Factors

Prepared by Mervin Yetley

APPENDIX D

Survey of 12 States

Prepared For

U. S. Animal and Plant Health Inspection Service

and

United States Animal Health Association

August 28, 1978

Brucellosis Social and Cultural Factors Influencing Producer's Attitudes and Knowledge

This study was originally conceived by members of the National Brucellosis Technical Commission. During the course of their public hearings, commission members became convinced of the importance of the human element in the success or failure of the Brucellosis Eradication Program. The author became involved as a result of existing working relationships already established with members of the Agricultural Economics Department at Texas A & M who were researching the economic impact of Brucellosis. This study was supported by funds from the National Brucellosis Technical Commission and administered through the Department of Agricultural Economics at Texas A & M University.

The author reviewed the notes of public hearings and attended the hearing held by the Commission on the Texas A & M campus in the summer of 1977. Discussions were held at that time with commission members regarding their views on the proper focus of research on human factors relating to the Brucellosis Eradication Program. General agreement was reached regarding the importance of knowledge, the sources of information and producers' attitudes. These three areas became the focus of the research and are the subject of this report.[1]

The study was conducted in three distinct geographical areas of Texas: the northeast, the mideast, and the midsouth. These areas were selected to minimize study expenses while maintaining a representative sample of Texas cattle raisers and dairymen, and to include known areas of high, medium and low prevalence of Brucellosis within Texas.

A sample of 100 commercial beef producers and 50 dairy operators was randomly drawn from a stratified list of producers provided by county extension agents and the Texas State Department of Health. The stratification was done to assure an adequate number of quarantined producers in the sample. The selected producers were interviewed on the farm by interviewers trained by the researchers. The incidence of refusal was negligible.

FINDINGS

Knowledge

Commission members and those familiar with the Brucellosis Eradication Program felt considerable confusion existed among producers regarding the "facts" about Brucellosis. It became a major objective of this research to quantify the extent of knowledge possessed by producers. Accordingly, a knowledge test was constructed with the aid of a member of the Brucellosis research group in the Texas A & M College of Veterinary Medicine.

---

[1] The work of Bruce Pinkerton is gratefully acknowledged. He contributed significantly to the questionnaire construction, data gathering and initial data analysis.

The knowledge questions were of the true-false variety and covered five areas. These were:

1. How the disease could be <u>contracted</u>
2. How it could be <u>prevented</u>
3. What are the <u>symptoms</u>
4. How does the eradication <u>program</u> work
5. How does the disease <u>affect humans</u>

These subareas were also totaled to give an overall <u>Knowledge</u> score. The score was calculated on the basis of "percentage of correct answers". In this calculation a "don't know" answer was scored as incorrect on the basis that had the producer known the answer, he would have given it.

Table 1 shows the true-false questions, the results of the knowledge test by subarea and the range of scores achieved by individual producers. The knowledge subarea with highest average score is "Symptoms", with 78.1 percent of the answers correct. The subarea with the lowest average score is "Affects Humans", with 55.4 percent correct. Knowledge of the area "Prevented" averaged only 60.0 percent correct, with "Program" and "Contracted" having an average of 65.6 and 72.0 percent correct respectively.

Individual producer knowledge scores ranged from 0.0 to 100.0 percent correct in all the subareas except "Symptoms" and "Program". In these two subareas all producers got at least one answer correct. For the total knowledge test the producers' scores ranged from 16.0 to 92.0 percent correct. The average percentage of correct answers for all producers for the total knowledge test was 64.2.

Table 2 shows knowledge categorized by subareas and cross tabulated with four discrete variables: prevalence level of brucellosis in the area, type of producer (beef versus dairy), control versus eradication as the respondent's desired brucellosis program objective and quarantine versus no quarantine experience. The figures within the body of the table represent the percentage of correct answers given by producers classified into a given cell.

Data on these discrete variables was specifically gathered because of their anticipated influence on knowledge levels. It seemed reasonable, for example, that quarantined producers would generally have better knowledge of brucellosis than nonquarantined producers due to first hand experience and possibly motivational factors. Similar arguments can be made for the other three discrete variables.

Investigating the influence of the discrete variables, considerable

variation was found to exist around the total sample averages. For example, in the area of "Prevention" all producers have an average score of 60.0 percent, but those in the low prevalence brucellosis area have an average score of 54.2 percent rising to 66.3 percent for producers in the high prevalence sample area. Further, dairymen have higher average scores in all areas of knowledge than do beef producers (see Table 2). The same may be said for producers who favor eradication over control as the major objective of the Brucellosis program. It also appears that producers who have been quarantined have higher average knowledge scores than those who have never been quarantined.

Also in Table 2 are the interaction terms of the discrete variables. All possible two, three and four way interaction terms have been included. Due to small cell numbers only a few of these interaction terms were expected to be statistically significant. However, for dairymen there is a definite trend toward higher average knowledge scores as higher level interactions are reached. For example, the average total score for dairymen is 72.6; for the two way interaction of dairymen in the high prevalence area the average total score increases to 79.7. Cross classifying this same group with those favoring eradication, a three way interaction, raises the average total score to 81.8. Again, using this same group in a four way interaction, i.e. dairymen in the high prevalence area favoring eradication and with quarantine experience, the average total score is 85.5. This compares with 60.0 for the (single) never quarantined dairyman favoring control in the low prevalence area.

For the beef producers the trend is less clear. The average knowledge score for all beef producers is 60.2, but increases to 66.8 if only those with quarantine experience are considered. Using these same producers, those favoring eradication have an average score of 60.6 versus 71.6 for those favoring control.

It is important to note that of these four discrete variables, only the belief that the brucellosis program objective should be control versus eradication is subject to outside manipulation. It is unreasonable to expect a producer to move geographically, switch from beef to dairy, or volunteer to be quarantined just to increase his knowledge of brucellosis. Other ways and other means will have to be found to achieve higher levels of producer knowledge about brucellosis.

Producers' knowledge of brucellosis was further analyzed to determine if clusters of questions existed. If it could be shown that producers knowing the correct answer to a question are also likely to know the correct (or incorrect) answer to other questions in the same (or different) knowledge area this would suggest that information "packages" are being used by producers. A combination of inter-item correlation and factor analysis was used in this analysis, but no interpretable pattern emerged, either within or between knowledge subareas. This strongly suggests producers are obtaining incomplete, misleading, or

false information, most likely from multiple sources. Almost any other situation would produce some patterning of the responses as opposed to the near random knowledge base that now exists.

Information Sources

The sources of information used by producers is reported in Table 3. Each producer selected and ranked the top three sources according to his confidence in the reliability of information received. With "1" indicating the highest reliability, local veterinarians received the highest average rank of 1.3. They were followed by the American Milk Producers, Inc. (1.5), Extension Agents (1.8), and the Texas State Department of Health (1.9). All other sources received an average rank of 2.0 or lower.[2]

The data in Table 3 also reveals that local veterinarians are called upon for information by 75.3 percent of the sample, more than for any other source. However, friends and neighbors are the most frequently used personal contact information source, averaging 12.7 contacts per year versus 5.9 reported for the local veterinarians. Mass media sources are used only slightly more frequently than are friends and neighbors. The Hoards Dairyman leads with an average reported use of 15.7 times per year for brucellosis information.[3]

It is of some interest to note the number of producers who report using the various sources. Although the local veterinarians have the highest rank and are the source used by the largest number of producers, the second ranking source, American Milk Producers, is utilized by only 8.7 percent of the respondents. This rate of utilization needs to be adjusted, however, to account for its specialized dairy audience. This would mean 13 of 50 potential users, or 26 percent reported obtaining brucellosis information from this source.

By comparison, 11.3 percent of the producers reported using the Farm Bureau as an information source, 14.7 percent utilized other agricultural associations and 12.7 percent used various cattle raisers associations. The adjusted frequency of use on this latter source would be 19 of 100 potential users or 19 percent. None of these sources was used an average of more than 6.6 times during the past year. Of these sources, the Farm Bureau received the highest reliability ranking (2.0), just ahead of friend and neighbors, with an average ranking of 2.1.

---

[2]Because only three information sources were selected and ranked, the rank reported for a source reflects the average of the rankings received. This avoids penalizing those sources not selected as one of the top three.

[3]Because of the specialized audience for several of the mass media sources, care must be exercised in interpreting these results.

Once an information source is used, it appears to be used for all types of information. Looking across the types of information columns in Table 3 reveals no clustering of any information source on any one information category. However, just the opposite occurs for the form of communication of the information. Verbal communication is by far the most frequently used method of gaining information. The use of pamphlets runs a distant second for the five sources ranking highest on reliability, but is the most frequently used method for the three lowest ranking sources. Personal written requests for information and attendance at movies and speeches appear to be important communication methods for extension agents only.

Some additional points in Table 3 should be noted. For instance, the average rank of friends and neighbors as a source of reliable information is 2.1, while that of the extension veterinarian is 2.2 and 2.6 for the cattle raisers associations. This points out the considerable importance of friends and neighbors as information sources, even on the technical subject of brucellosis disease. It is unlikely that many producers have even one friend or neighbor possessing the technical information that would objectively qualify this person to act as a reliable information source on brucellosis. Yet, 56.0 percent of the producers make an average of 12.7 contacts a year to obtain brucellosis information from friends and neighbors. Obviously, producers use readily available sources they feel are reliable. Whether the information obtained was correct cannot be determined from the data in this study. The evidence from the preceeding knowledge section suggests a considerable amount of this information is not correct.

Another point to consider is the attitude of the information source toward the brucellosis program. The producers were asked to rate how their three major information sources feel about the brucellosis program. The producers were asked to rate how their three major information sources feel about the brucellosis program. They could choose any one of five responses ranging from 1 = very favorable through 3 = no opinion to 5 = very unfavorable. The average degree of favorableness for all information sources chosen as the first of the three major sources used was 2.27. This is primarily, but not entirely, a reflection of the attitude of the local veterinarians. The average value for both the second and third major sources was 2.35. Neither of these values indicates much enthusiasm for the program. This suggests that the most frequently used sources, which are also those viewed as highly reliable, do not fully endorse the program. Obviously, this makes it very difficult to create a favorable program image among producers.

The magnitude of the problem becomes even more apparent when the slightly negative attitudes of other cattle raisers in the area and close friends and neighbors are considered. The average score for these groups was 3.13 and 3.07 respectively on the same scale use above.

Knowledge as the Dependent Variable

In the previous section variations in knowledge about brucellosis was investigated with respect to four discrete variables. Only one of these variables was manipulable. Thus, there is a need to determine if other variables exist which will predict and explain producer's knowledge scores. Accordingly, total knowledge of brucellosis and the subarea knowledge scores were used as dependent variables in regression analysis. The results are shown in Table 4.

Basically, knowledge of brucellosis is not highly predictable from the data gathered in this study. The R^2 values from the regression analyses range from "not significant" to 63.8 percent. The non-significant regression occurred in the beef producer subsample in the knowledge area of "how Brucellosis is contracted". The highest R^2 value occurred in the dairy subsample for the total knowledge score. From the data presented in Table 4, it is clear dairymen are more highly predictable in terms of their brucellosis knowledge than are beef producers.

In the regression analysis, the discrete variables were forced in to the equation as "dummy" variables. The continuous variables of interest were then allowed to enter the equations on a "maximum increase in R^2" basis on the initial computer runs.[4] Non-significant variables were dropped from the equations and the remaining significant continuous variables were standardized and the analysis rerun.

From the results shown in Table 4, the discrete variables do not predict particularly well in any of the knowledge subareas except for "knowledge of prevention" among dairymen. In this instance, each of the discrete variables[5], and the interaction between incidence level and control versus eradication, were found significant. For the beef producers, the discrete variables are very poor predictors of knowledge, as would be expected from the previous discussion of Table 2. Only in "knowledge of the brucellosis program" do the discrete variables achieve predictive importance when compared to the continuous variables.

As opposed to the discrete variables, the continuous variable, level of education, is an important positive predictor of brucellosis knowledge for beef producers. More education significantly predicts greater knowledge of "Prevention", "Symptoms", "Affects Humans" and total knowledge. Note, however, that education is not a significant predictor for dairymen. This suggests that formal education is not a prerequisite for gaining knowledge of brucellosis.

---

[4] The SAS users package was used in all computer analyses except where otherwise noted.

[5] The discrete variable of beef versus dairy is omitted from the regression analysis because these two subsamples are treated separately.

Three types of income data were obtained. Level of income was obtained by having producers check one of six total income categories. Additionally, producers estimated the percentage of total income derived from their farm or ranch and also the percentage of total income derived from their cattle or dairy operation. Level of income positively predicts knowledge of "prevention" and "total knowledge" for both beef producers and diarymen. For dairymen, the larger their percentage of their income from the farm, the greater their knowledge of "symptoms". Further, for dairymen the larger their percentage of income from dairying, the <u>less</u> their total knowledge score.

This latter relationship seems inconsistent with the findings discussed previously. Additional analysis revealed a slightly better fit of the data was obtained by using the log of the income level. Thus, knowledge does not increase linearly as income increases. However, the negative relationship with percentage of income from dairying remained statistically significant. A check on the correlation between percentage of income from dairying and total income revealed a very low correlation, $r = 0.25$, significant at the 0.08 level.[6] Thus, even though both variables measure income, there is no reason statistically why their relationships to knowledge must be consistent. The negative relationships to knowledge must be consistent. The negative relationship of percentage of income from dairying to total knowledge implies that those dairymen deriving a substantial portion of their total income from dairying are less knowledgeable about brucellosis than those having other sources of income.

Density of the herd on the farm or ranch was measured as animals per acre and was included as a measure of intensity of the operation. The expectation was for greater intensity to be associated with greater knowledge of brucellosis. This relationship was not found. This variable is significant only for dairymen in their knowledge of "how brucellosis affects humans". Further, this relationship is negative. An explanation for this has not been found.

The percentage of the herd vaccinated for brucellosis was found to be positively associated to knowledge areas of "prevention" (beef) and "symptoms" and "affects humans" (dairy). Whether vaccination occurs before or after accumulation of knowledge is not known from the data. However, given the history of the Brucellosis Program in Texas, it seems reasonable that initial experience with vaccination was such as to cause producers to seek out information on "prevention" and "symptoms". However, either a negative or positive experience with brucellosis vaccine could trigger information-seeking behavior.

For the dairymen, their beliefs about brucellosis (see Appendix A for the attitude statements) is negatively related to knowledge of the

---

[6] This same correlation for cattle producers was even lower, $r = -0.05$, which is not statistically different from zero.

program. Given the content of the variable "belief", this was expected. Beliefs were not expected to relate positively to any of the knowledge areas. However, for beef producers this variable shows a significant positive relationship to knowledge of "symptoms". It appears contradictory for beef producers to agree with the statements making up the belief attitude scale, yet score relatively high on knowledge of symptoms. This finding is consistent, however, with the earlier suggestion of multiple, poorly informed information sources dispensing inaccurate or misleading information on brucellosis.

The favorability toward the brucellosis program of the information sources used by producers is a significant predictor of knowledge for dairymen only. The relationship is positive for knowledge of how the disease is "contracted", its "symptoms" and total knowledge. Since the favorability of the information sources refers to those sources the producers selected as most reliable (see Table 3), this finding is quite important. It suggests one or both of two possibilities. First, those sources reported to be more favorable toward the brucellosis program have better knowledge of brucellosis and are successful in transferring that knowledge to those procedures with whom contact is established. The second possibility is that knowledgeable producers seek out sources that are favorable toward the brucellosis program.[7] Both possibilities have important implications for any attempts to improve the brucellosis program because both suggest a favorable opinion of the program by the information source enhances producers' knowledge.

Three attitude variables involving producers' feelings about the federal government and its involvement in agriculture and the brucellosis program were included in the study. The statements used are listed in Annex A.

A series of three statements were used to determine producers' feelings about the federal government's involvement in the brucellosis program. On the average, the producers are somewhat negative toward federal involvement and this variable has a negative relationship to beef producers' knowledge of symptoms and the brucellosis program.[8] It appears beef producers with misgivings about the federal government "turn-off" or avoid information about brucellosis. However, these relationships do not hold for dairymen. This finding has important implications regarding any possible changes in the current program.

---

[7] A logical extension of this second possibility suggests that knowledgeable producers are themselves favorable toward the brucellosis program. As is pointed out in the next section, this expectation was not supported.

[8] The average producer has a somewhat negative attitude value of 4.6 on an eleven point scale where 6.0 is the neutral point. Also, a similar series of statements for state government was included, but were not significant predictions of knowledge.

Producers' attitudes on overall (generalized) concern for government was also measured. On this variable the average attitude was almost exactly neutral. However, the relationship of this variable to knowledge of "how brucellosis is contracted" and "how it affects humans" is positive for dairymen. Here again, the importance of producer attitudes toward government and its association with knowledge of brucellosis is shown and is consistent with the finding immediately above for beef producers.

Producers' "concern for the political power of agriculture" was investigated. Producers feel agriculture has very little political power as the average attitude score was 2.3 on the same eleven point scale used previously. It was expected that producers with feelings of political powerlessness would have less knowledge of brucellosis because of the association the brucellosis program has with government. This expectation was not supported. In fact, the only significant relationship between this variable and knowledge is a positive one for dairymen in the "affects humans" area.

Attitude Toward the Brucellosis Program

Because participation in the brucellosis program is essentially nonvoluntary, valid behavorial measures of producers' feelings about the program are not available. However, producers' attitudes towards the program were measured. This measure, or attitude scale, is reported in Annex A as General Attitude Toward the Brucellosis Program, i.e., the producers' generalized attitude about the brucellosis program. This measure is used as the dependent variable in the analysis of this section.

In Table 5, producers' attitudes toward the brucellosis program are analyzed using the same four discrete variables used previously in the discussion of knowledge. Responses to the attitude statements were obtained on an eleven point scale. Responses could range from "strongly disagree" through "no opinion" to "strongly agree" on each statement. The neutral, or no opinion, point on the eleven point scale is 6.0. Larger scale values indicate a more positive attitude toward the brucellosis program.

For the total sample, the average producer holds an attitude that rates 6.7, or just slightly positive. As was found for knowledge, the attitudes of producers vary considerably around this overall average when the producers are classified according to the discrete variables.

Producers in the areas of low and high brucellosis prevalence have more positive attitudes, 7.20 and 7.15, than producers in the medium prevalence area, 5.80. In fact, the average attitude in the area of medium prevalence is slightly negative.

As opposed to knowledge, where dairymen were better informed than cattlemen, the attitudes are very similar, 6.63 and 6.86 for cattlemen

and dairymen respectively. A slightly larger difference is found for producers favoring control, 6.37, versus those favoring eradication, 7.10. Producers who have been quarantined are slightly favorable toward the program, 6.32, while those never quarantined are somewhat more favorable, 7.04.

Although the trend is not as consistent as was found for knowledge among dairymen, attitudes toward the brucellosis program do become more favorable in certain of the discrete variable higher order interaction terms. Beef producers in the low brucellosis prevalence area have an average attitude score of 7.23, while those in the high prevalence area have a less favorable attitude of 6.84. For dairymen the situation reverses. Those in the low prevalence area have an average attitude score of 7.07, while those in the high prevalence area are more favorable at 7.60. In the low prevalence area quarantined beef producers have an average attitude score of 6.58, while the dairymen's score is 6.54, which is a negative overall attitude. In the high prevalence area these same scores are 6.96 and 6.71 respectively. The most favorable attitudes are held by never quarantined dairymen in the area of high prevalence of brucellosis, with an average attitude score of 8.89. These data suggest that the quarantine experience is less traumatic for beef producers than it is for dairymen.

As was done in the previous analysis for knowledge, separate regressions were run for the beef and dairy subsamples. The significant discrete variables were again forced into the model as dummy variables with the continuous variables selected on the basis of the "max R^2" routine in the SAS computer package.

The first point noticed in Table 6 was the few common predictor variables between the beef and dairy models. Secondly, the dairy model achieves a higher R^2 on considerably fewer variables than the beef model. This supports the analysis of beef producers and dairymen as separate subsamples in the sense that they appear to respond to quite different factors.

The beef producers' attitudes were more influenced by the discrete variables than was found for dairymen. For the dairymen, only the discrete variables of prevalence level and quarantine experience are significant predictors of attitude toward the brucellosis program.

For the beef producers level of education is negatively related to the attitude variable, as is the level of income and knowledge of prevention. None of these variables is a significant predictor of dairymen's attitudes. Thus, for beef producers, the better their education, the higher their total income and the more knowledgeable they are of brucellosis prevention, the lower their opinion of the brucellosis program. These are important points to consider in any future changes that may be made in promoting the program.

Beef producers' attitudes toward the program are significantly and positively influenced by the "feelings of friends and neighbors" and by the "extent of favorability of information sources". Here again, neither of these variables is a significant predictor for dairymen. For whatever reason, beef producers are vulnerable to the opinions of others, whereas dairymen appear to be unaffected.

With respect to the political attitudes, "federal involvement in the brucellosis program" has a negative relationship with producers' general attitude toward the program. This negative relationship was significant for both cattlemen and dairymen. The attitude regarding "overall concern for government" was found to have a significant positive relationship to the general attitude toward the brucellosis program for beef producers only. It should be noted that this latter relationship is not necessarily inconsistent with nor opposite to the negative relationship found regarding federal involvement in the brucellosis program. There is no logical reason why a producer who opposes government involvement in the current brucellosis program should also be antigovernment in the general sense. However, the results found for these political attitudes does have important implications for any future changes in the nature of the brucellosis program.

Although size of operation, measured in acres, was a significant negative predictor of dairymen's general attitude toward the brucellosis program, no clear relationship of size to this attitude was found.

Two variables found to be highly significant and positive predictors of dairymen's general attitude but not significant for beef producers were the producers' "willingness to sacrifice to eradicate brucellosis" and his "view of the seriousness of the disease". This finding suggests more information on the economic impact of brucellosis in the producer's herd would be favorably received by dairymen but ignored by most cattlemen. The implications of this for any future changes in the implementation of the brucellosis program are obvious.

The last variable to be discussed in this section involves the producers' "opinion of specific points regarding brucellosis and the brucellosis program". At first glance this variable appears to have the same content as the general attitude variables. However, producers can certainly debate and dispute certain points regarding either the disease itself or the program without necessarily being against the program in general. The data seem to support this reasoning. While this variable does have the strongest (largest standardized regression coefficient) negative relationship to the general attitude variable, for dairymen this relationship is only slightly stronger than the relationship involving "willingness to sacrifice". For cattlemen, this relationship is approximately 50 percent stronger than the next most important predictor, "knowledge of prevention". For dairymen, this variable alone accounts for approximately 30 percent of the variance in producers general attitude toward the brucellosis program. For cattle-

men, the corresponding figure is 25 percent. Thus, while negative feelings and opinions about specific points regarding brucellosis and the brucellosis program were predictably found associated with negative general attitudes toward the program, it is important to note that feelings and opinions about specific points are not the entire picture and that the other variables already discussed, when considered together, are the more important predictors of the general attitude.

Summary and Implications

Evidence has been presented that knowledge of brucellosis among Texas cattle producers and dairymen is inadequate. Although dairymen possess better knowledge, on the average, than do cattle producers, neither group has sufficient systematic knowledge for wise decisions. No interpretable pattern of knowledge (correct answer) was found. This suggests the information producers are currently getting is inadequate, incomplete, incorrect and probably also conflicting.

The sources of information were investigated and it was found that the local veterinarian is the most frequently used source, followed by friends and neighbors. Producers rated the local veterinarian as the most reliable information source. County extension agents and the Texas Department of Health also ranked high on reliability. Except for the American Milk Producers, Inc., the various producer associations were not seen as highly reliable sources of information on brucellosis, nor were they frequently used as information sources. Since the knowledge base is so low and correct answers to the knowledge question appear to be nearly random, it seems clear that these information sources are not adequate for the task in either quality or quantity of information. Given the data, even the quality of the information from the local veterinarians should be questioned, for they are the most frequently used source and viewed as the most reliable. Surely if their information were adequate in quality and quantity, the knowledge of producers would be higher than was found in this study.

These data suggest that federal government involvement should be minimized in appearance if not also in principle. The reason for this is the selectivity in perception all humans practice. In this instance, producers seem sufficiently unenthused about government involvement to cause them to (a) discount information coming from a government associates source, or (b) avoid such a source entirely.

Since level of income is a consistent predictor of knowledge, this implies the need to emphasize the economic impact of brucellosis as a motivation to producers to seek reliable information. In effect, this could replace a negative incentive (government involvement in terms of program requirements to clean up a herd) with a positive incentive (greater economic payoff through prevention).

Further, it seems important that information sources be qualified to give correct technical information on brucellosis, to be positive

toward the brucellosis program and to maintain creditability in the eyes of producers. It is virtually impossible for the local veterinarian and extension agent to meet these three criteria simultaneously. If they maintain an openly positive attitude toward the program, they run the risk of loosing their creditability with producers who will then avoid them as information sources. The possibility that these groups may lack adequate technical information is also a possibility judging from the data on producers' knowledge.

Beef producers and dairymen appear to be two distinct groups, especially with respect to factors influencing their attitude toward the brucellosis program. However, on the two variables common to both the beef and dairy models, opinion of the specifics of the program and federal involvement, the producers agree the influence is negative. With respect to knowledge, both types of producers are positively influenced by economic considerations.

Table 1: Brucellosis Knowledge Questions by Subarea

KNOWLEDGE		Sample Average (Percent Correct)
Contracted:	Brucellosis is only found in cattle.	72.0
	Brucellosis is spread by direct contact between animals.	57.3
	The fetus and after birth of an abortion due to Brucellosis is a major source of potential infection for other livestock.	87.3
	Category Average:	72.0
	Individual Producer Category: Low Score: 0.0 High Score: 100.0	
Prevented:	Purchased replacement stock should be kept separate from your main herd for 60-120 days and be tested to insure they don't have Brucellosis.	86.0
	Keeping calving barns and pens clean of manure will prevent the spread of Brucellosis.	57.3
	Heifers should be vaccinated against Brucellosis as soon as possible after two months of age.	69.3
	It is also recommended that male calves be vaccinated against Brucellosis.	50.0
	Calfhood vaccinated cattle need a second injection of strain 19 at first breeding to maintain immunity.	36.7
	Category Average:	60.0
	Individual Producer Category: Low Score: 0.0 High Score: 100.0	
Symptoms:	Cows exposed to Brucellosis may not show any sign of the disease for several months.	93.3
	Brucellosis always causes abortions in livestock.	72.0

	Brucellosis causes a decrease in milk production in cows.	62.0
	Brucellosis infected cows can have normal appearing calves.	84.7
	Brucellosis is a reproductive disease.	80.0
	Category Average:	78.1
	Individual Producer Category: Low Score: 20.1 High Score: 100.0	
Program:	Brucellosis reactor cattle must be sold for slaughter within 15 days.	75.3
	Herds are released from quarantine after 120 days provided two consecutive herd tests have been negative.	84.0
	Cattle that have been exposed to Brucellosis must be slaughtered.	59.7
	Reactor cattle may be sent to a quarantine feedlot or returned to the herd to await retesting.	58.0
	Reactor cattle going to slaughter are not required to be branded "B".	78.0
	Indemnity is automatically paid to producers that sell reactor cattle for slaughter.	39.3
	Category Average:	65.6
	Individual Producer Category: Low Score: 16.6 High Score:100.0	
Affect on Humans:	Brucellosis cannot be transmitted from animals to humans.	64.7
	Brucellosis in humans is called undulant fever.	81.3
	Humans cannot get Brucellosis by drinking milk from an infected cow.	61.3
	Undulant fever acts a lot like the flu.	47.3

Incidence of cases of human Brucellosis has been increasing in the last four years.	22.0
Category Average:	55.4

Individual Producer Category: Low Score: 0.0
High Score: 100.0

Total (Knowledge):	64.2

Individual Producer Total Knowledge: Low Score: 16.0
High Score: 92.0

Table 2: Brucellosis Study: Knowledge Test

(Sub) Samples		Knowledge Areas (Percent Correct) Contracted	Prevented	Symptoms	Programs	Affects Humans	Total
Total	N=150	72.0	60.0	78.1	65.6	55.4	64.2
Sample Area							
Low incidence	N=38	71.9	54.2	76.8	60.1	52.6	61.4
Medium incidence	N=49	71.4	57.1	79.2	64.3	49.0	61.9
High incidence	N=57	72.5	66.3	77.9	70.5	62.8	68.1
Producer Type							
Beef	N=98	68.4	55.1	73.3	64.1	49.0	60.2
Dairy	N=46	79.7	70.4	88.3	68.8	69.1	72.6
Program Objective							
Control	N=79	70.5	58.7	75.7	63.9	54.9	62.6
Eradication	N=65	73.8	61.5	80.9	67.7	56.0	66.1
Brucellosis Experience							
Quarantined	N=68	75.0	67.1	81.8	73.3	58.5	69.1
Never quarantined	N=76	69.3	53.7	74.7	58.8	52.6	59.8
Beef Producers in:							
Low incidence	N=30	67.8	52.0	76.7	61.7	50.0	60.3
Medium incidence	N=34	71.6	55.3	72.9	65.2	45.9	60.2
High incidence	N=34	65.9	57.6	70.6	65.2	51.2	60.2
Dairymen in:							
Low incidence	N=8	87.5	62.5	77.5	54.2	62.5	65.5
Medium incidence	N=15	71.1	61.3	93.3	62.2	56.0	65.6
High incidence	N=23	82.6	79.1	8877	78.3	80.0	79.7
Producers Favoring Control in:							
Low incidence	N=16	70.8	45.0	72.5	58.3	53.8	58.3
Medium incidence	N=33	73.7	60.6	76.4	64.6	53.3	63.3
High incidence	N=30	66.7	64.0	76.7	66.1	57.3	64.3

Knowledge Areas
(Percent Correct)

(Sub) Samples		Contracted	Prevented	Symptoms	Programs	Affects Humans	Total
Producers Favoring Eradication in:							
Low incidence	N=22	72.7	60.9	80.0	61.4	51.8	63.6
Medium incidence	N=16	66.7	50.0	85.0	63.5	40.0	59.0
High incidence	N=27	79.0	68.9	79.3	75.3	68.9	73.0
Quarantined Producers in:							
Low incidence	N=17	70.5	54.1	81.2	66.7	52.9	64.0
Medium incidence	N=22	74.2	64.5	87.3	72.0	50.9	67.3
High incidence	N=29	78.2	76.6	77.9	78.2	67.6	73.4
Never Quarantined Producers in:							
Low incidence	N=21	73.0	54.3	73.3	54.8	52.4	59.2
Medium incidence	N=27	69.1	51.1	72.6	58.0	47.4	57.5
High incidence	N=28	66.7	55.7	77.9	62.5	57.9	62.6
Beef Producers Favoring:							
Control	N=63	68.8	55.2	72.4	64.0	51.7	60.6
Eradication	N=35	67.6	54.9	74.9	64.3	44.7	59.7
Dairymen Favoring:							
Control	N=16	77.1	72.5	88.8	63.5	67.5	70.8
Eradication	N=30	81.1	69.3	88.0	71.7	70.0	73.6
Beef Producers with:							
Quarantine experience	N=44	70.5	60.5	76.8	73.5	52.7	65.2
No quarantine experience	N=54	66.7	50.7	70.4	56.5	45.9	56.2
Dairymen with:							
Quarantine experience	N=24	83.3	79.2	90.3	72.9	69.2	76.2
No quarantine experience	N=22	75.8	69.9	85.5	64.4	69.0	68.7
Producers Favoring Control with:							
Quarantine experience	N=36	75.0	70.0	82.2	72.7	60.6	69.4
No quarantine experience	N=43	66.7	49.3	70.2	56.6	50.2	56.9

(Sub) Samples		Knowledge Areas (Percent Correct) Contracted	Prevented	Symptoms	Programs	Affects Humans	Total
Never Quarantined Beef Producers in:							
Low incidence	N=15	53.3	73.3	53.3	66.7	48.0	57.1
Medium incidence	N=21	50.5	67.6	59.5	71.4	46.7	57.1
High incidence	N=18	48.9	71.1	55.6	61.1	43.3	54.4
Never Quarantined Dairymen in:							
Low incidence	N=6	56.7	73.3	58.3	88.9	63.3	64.7
Medium incidence	N=6	53.3	90.0	52.8	61.1	50.0	58.7
High incidence	N=10	68.0	90.0	75.0	76.7	84.0	77.2
Quarantined Producers Favoring Control in:							
Low incidence	N=7	45.7	80.0	64.3	76.2	60.0	62.9
Medium incidence	N=15	72.0	85.3	74.4	75.6	52.0	69.3
High incidence	N=14	80.0	80.0	75.0	73.8	70.0	72.8
Quarantined Producers Favoring Eradication in:							
Low incidence	N=10	50.0	82.0	68.3	66.7	48.0	64.8
Medium incidence	N=7	48.6	91.4	66.7	71.4	48.6	62.9
High incidence	N=15	73.3	76.0	81.1	82.2	65.3	73.9
Never Quarantined Producers Favoring Control in:							
Low incidence	N=9	44.4	66.7	53.7	66.7	48.9	54.7
Medium incidence	N=18	51.1	68.9	56.5	72.2	54.4	58.2
High incidence	N=16	50.0	73.8	58.3	60.4	46.3	56.8
Never Quarantined Producers Favoring Eradication in:							
Low incidence	N=12	61.7	78.3	55.6	77.8	55.0	62.7
Medium incidence	N=9	51.1	80.0	61.1	63.0	33.3	56.0
High incidence	N=12	63.3	83.3	68.1	75.0	73.3	70.3

(Sub) Samples		Knowledge Areas (Percent Correct) Contracted	Prevented	Symptoms	Programs	Affects Humans	Total
Quarantined Beef Producers Favoring:							
Control	N=25	64.0	78.4	76.7	73.3	57.6	57.8
Eradication	N=19	55.8	74.7	69.3	66.7	46.3	61.7
Quarantined Dairymen Favoring:							
Control	N=11	83.6	90.0	63.6	78.8	67.3	73.1
Eradication	N=13	75.4	90.8	80.8	87.2	70.8	78.8
Never Quarantined Beef Producers Favoring:							
Control	N=38	49.5	68.4	55.7	65.8	47.9	55.8
Eradication	N=16	53.8	75.0	58.3	68.8	41.3	57.2
Never Quarantined Dairymen Favoring:							
Control	N=5	48.0	84.0	63.3	73.3	68.0	55.6
Eradication	N=17	64.8	85.9	64.7	76.5	69.4	69.6
Quarantined Beef Producers Favoring Control in:							
Low incidence	N=6	43.3	76.7	69.4	77.8	60.0	63.3
Medium incidence	N=10	68.0	80.0	78.3	70.0	48.0	67.2
High incidence	N=9	73.3	77.8	79.6	74.1	66.7	71.6
Quarantined Dairymen Favoring Control in:							
Low incidence	N=1	60.0	100.0	33.3	66.7	60.0	60.0
Medium incidence	N=5	80.0	96.0	66.7	86.7	60.0	73.6
High incidence	N=5	92.0	84.0	66.7	73.3	76.0	75.2

(Sub) Samples		Knowledge Areas (Percent Correct) Contracted	Prevented	Symptoms	Programs	Affects Humans	Total
Quarantined Beef Producers Favoring Eradication in:							
Low incidence	N=9	55.6	82.2	70.4	63.0	46.7	63.6
Medium incidence	N=3	46.7	86.7	61.1	77.8	33.3	58.7
High incidence	N=7	60.0	60.0	71.4	66.7	51.4	60.6
Quarantined Dairymen Favoring Eradication in:							
Low incidence	N=1	100.0	80.0	50.0	100.0	60.0	76.0
Medium incidence	N=4	50.0	95.0	70.8	66.7	60.0	66.0
High incidence	N-8	85.0	90.0	80.6	95.8	77.5	85.5
Producers Favoring Eradication with;							
Quarantine experience	N=32	75.0	63.8	81.3	74.0	56.3	68.6
No quarantine experience	N=3	72.7	59.4	80.6	61.6	55.8	63.6
Beef Producers Favoring Control in:							
Low incidence	N=14	45.7	71.4	59.5	69.0	52.9	58.0
Medium incidence	N=26	57.7	71.5	65.4	71.8	51.5	61.5
High incidence	N=23	58.3	73.9	65.2	65.2	51.3	61.0
Dairymen Favoring Control in:							
Low incidence	N=2	40.0	80.0	50.0	83.3	60.0	60.0
Medium incidence	N=7	71.4	94.3	61.9	81.0	60.0	70.0
High incidence	N=7	82.9	85.7	69.0	71.4	77.1	74.9
Beef Producers Favoring Eradication in:							
Low incidence	N=16	57.5	81.3	63.5	66.7	47.5	62.3
Medium incidence	N=8	47.5	77.5	64.6	70.8	27.5	56.0
High incidence	N=11	56.4	63.6	65.2	66.7	50.9	58.5

Knowledge Areas
(Percent Correct)

(Sub) Samples		Contracted	Prevented	Symptoms	Programs	Affects Humans	Total
Dairymen Favoring Eradication in:							
Low incidence	N=6	70.0	76.7	55.6	88.9	63.3	67.3
Medium incidence	N=8	52.5	92.5	62.5	62.5	52.5	62.0
High incidence	N=16	77.5	90.0	82.3	87.5	81.3	81.8
Quarantined Beef Producers in:							
Low incidence	N=15	50.7	80.0	70.0	68.9	52.0	63.5
Medium incidence	N=13	63.1	81.5	74.4	71.8	44.6	65.2
High incidence	N=16	67.5	70.0	76.0	70.8	60.0	66.8
Quarantined Dairymen in:							
Low incidence	N=2	30.0	90.0	41.7	83.3	60.0	68.0
Medium incidence	N=9	66.7	95.6	68.5	77.8	60.0	70.2
High incidence	N=13	87.7	87.7	80.8	87.2	76.9	81.5
Never Quarantined Beef Producers Favoring Control in:							
Low incidence	N=8	47.5	67.5	52.1	62.5	47.5	54.0
Medium incidence	N=16	51.3	66.3	57.3	72.9	53.8	58.0
High incidence	N=14	48.6	71.4	56.0	59.5	41.4	54.3
Never Quarantined Dairymen Favoring Control in:							
Low incidence	N=1	20.0	60.0	66.7	100.0	60.0	60.0
Medium incidence	N=2	50.0	90.0	50.0	66.7	60.0	60.0
High incidence	N=2	60.0	90.0	75.0	66.7	80.0	74.0
Never Quarantined Beef Producers Favoring Eradication in:							
Low incidence	N=7	60.0	80.0	54.8	71.4	48.6	60.6
Medium incidence	N=5	48.0	72.0	66.7	66.7	24.0	54.4
High incidence	N=4	50.0	70.0	54.2	66.7	50.0	55.0

Knowledge Areas
(Percent Correct)

(Sub) Samples		Contracted	Prevented	Symptoms	Programs	Affects Humans	Total
Never Quarantined Dairymen Favoring Eradication in:							
Low incidence	N=5	64.0	76.0	56.7	86.7	64.0	65.6
Medium incidence	N=4	55.0	90.0	54.2	58.3	45.0	58.0
High incidence	N=8	70.0	90.0	75.0	79.2	85.0	78.0

Table 3: Sources of Information

Sources	Percent Using		Average Number of Uses Per Year	Type of Information					Form of Information					Reliability Average Rank
	No.	%		Contracted	Pre-vented	Symp-toms	Treat-ment	Program	Pamphlet	Personal	Verbal	Movie	Speech	
Local Veterinarian	113	75.3	5.9	84	86	77	75	69	16	6	103	4	5	1.3
American Milk Producers, Inc.	13	8.7	8.7	9	7	11	8	7	5	5	7	0	1	1.5
Extension Agents	57	38.0	4.3	45	42	41	37	40	22	10	46	11	11	1.8
Texas State Dept. of Health	56	37.3	5.9	38	40	36	37	40	22	12	44	1	2	1.9
Farm Bureau	17	11.3	6.2	12	12	9	8	10	10	3	7	0	2	2.0
Friends and Neighbors	84	56.0	12.7	68	58	59	53	51	1	0	76	0	1	2.1
"Other" Agri-culture Assoc.	22	14.7	5.4	16	15	16	12	16	10	4	11	4	4	2.1
Extension Veterinarian	26	17.3	5.7	21	17	15	18	18	5	4	23	1	1	2.2
Hoards Dairyman	8	5.3	15.7	7	5	4	4	3	6	0	1	0	0	2.2
Salesman--Farm Supply	14	9.3	5.9	9	9	8	7	5	3	0	12	0	0	2.3
Feed Store Workers	23	15.3	8.0	16	10	11	9	5	0	0	23	0	0	2.4
Progressive Farmer	19	12.7	12.8	13	13	10	10	10	14	0	1	0	0	2.5
Cattle Raisers Assoc.	19	12.7	6.6	15	16	14	14	14	10	2	7	1	2	2.6
"Other" Magazines	29	19.3	13.3	26	27	25	25	24	26	3	4	1	1	2.7

Table 4: Prediction of Knowledge Scores**

Predictor Variables	Contracted		Prevented		Symptoms		Program		Affects Humans		Total Knowledge	
	Beef	Dairy	Beef	Dairy	Beef	Dairy	Beef	Dairy	Beef	Dairy	Beef	Dairy
Discrete Variables												
Incidence level of Brucellosis (geographical area)				*(4.3)			*(2.5)***	*(9.2)				*(18.6)
Control vs. Eradication				*(3.5)								
Experinece with Brucellosis (quarantined vs. never quarantined)				*(5.0)		*(6.9)						
Discrete Interaction Terms												
Incidence level by control vs. eradication				*(7.3)			*(25.2)				*(4.5)	
Continuous Variables												
Level of education			+.41(24.1)		+.29(9.8)				+.34(13.0)		+.38(17.6)	
Percent of income from cattle or dairy												-.29(8.1)
Percent of income from farm or ranch						+.43(9.9)						
Level of income			+.22(7.2)	+.36(7.6)							+.17(3.8)	+.33(11.7)
Density of herd on the farm or ranch										-.40(11.0)		-.24(6.2)
Percentage of herd vaccinated			+.18(4.7)			+.23(3.2				+.39(10.2)		
Beliefs about Brucellosis					+.21(4.1)			-.22(2.8)				
Favorability of information sources toward Brucellosis Program		+.28(4.3)				+.28(5.3)						+.40(17.5)

Predictor Variables	Contracted		Prevented		Symptoms		Program		Affects Humans		Total Knowledge	
	Beef	Dairy	Beef	Dairy	Beef	Dairy	Beef	Dairy	Beef	Dairy	Beef	Dairy
Continuous Variables												
Overall concern for government		+.24(3.0)								+.58(11.6)		
Concern for political power of agriculture										+.57(11.5)		
R^2 =	N.S.	17.4	31.0	46.0	13.4	38.0	25.4	24.7	12.0	39.2	28.1	63.8

**Values shown are Standardized Regression Coefficients. A column represents a regression model and within a given model (column) the standardized regression coefficients may be directly compared. The coefficients are not comparable across models (rows). The values in parenthesis are partial F values. For significant discrete variables, the standardized regression coefficient has been replaced by an *. Lack of any entry indicates nonsignificance. All values significant at 0.10 level or better.

***This value significant at 0.12 level.

Table 5: Attitude Toward the Brucellosis Program

(Sub)Samples	Sample Size	General Attitude Score
Total	150	6.70
Sample Area		
Low incidence	38	7.20
Medium incidence	49	5.80
High incidence	57	7.15
Producer Type		
Beef	98	6.63
Dairy	46	6.86
Program Objective		
Control	79	6.37
Eradication	65	7.10
Brucellosis Experience		
Quarantined	68	6.32
Never Quarantined	76	7.04
Beef Producers in:		
Low incidence	30	7.23
Medium incidence	34	5.88
High incidence	34	6.84
Dairymen in:		
Low incidence	8	7.07
Medium incidence	15	5.61
High incidence	23	7.60
Producers Favoring Control in:		
Low incidence	16	7.38
Medium incidence	33	5.70
High incidence	30	6.57
Producers Favoring Eradication in:		
Low incidence	22	7.06
Medium incidence	16	6.01
High incidence	27	7.78
Quarantined Producers in:		
Low incidence	17	6.47
Medium incidence	22	5.51
High incidence	29	6.85
Never Quarantined Producers in:		
Low incidence	21	7.79
Medium incidence	27	6.03
High incidence	28	7.45
Beef Producers Favoring:		
Control	63	6.49
Eradication	35	6.88

(Sub) Samples	Sample Size	General Attitude Score
Dairymen Favoring:		
Control	16	5.91
Eradication	30	7.37
Beef Producers with:		
Quarantine experience	44	6.32
No quarantine experience	54	6.88
Dairymen with:		
Quarantine experience	24	6.32
No quarantine experience	22	7.45
Producers Favoring Control with:		
Quarantine experience	36	5.97
No quarantine experience	43	6.70
Producers Favoring Eradication with:		
Quarantine experience	32	6.71
No quarantine experience	33	7.48
Beef Producers Favoring Control in:		
Low incidence	14	7.58
Medium incidence	20	5.82
High incidence	23	6.57
Dairymen Favoring Control in:		
Low incidence	2	6.00
Medium incidence	7	5.22
High incidence	7	6.57
Beef Producers Favoring Eradication in:		
Low incidence	16	6.93
Medium incidence	8	6.07
High incidence	11	7.39
Dairymen Favoring Eradication in:		
Low incidence	6	7.43
Medium incidence	8	5.95
High incidence	16	8.05
Quarantined Beef Producers in:		
Low incidence	15	6.58
Medium incidence	13	5.24
High incidence	16	6.96

(Sub) Samples	Sample Size	General Attitude Score
Quarantined Dairymen in:		
Low incidence	2	5.64
Medium incidence	9	5.90
High incidence	13	6.71
Never Quarantined Beef Producers in:		
Low incidence	15	7.89
Medium incidence	21	6.28
High incidence	18	6.73
Never Quarantined Dairymen in:		
Low incidence	6	7.55
Medium incidence	6	5.17
High incidence	10	8.76
Quarantined Producers Favoring Control in:		
Low incidence	7	6.57
Medium incidence	15	5.28
High incidence	14	6.42
Quarantined Producers Favoring Eradication in:		
Low incidence	10	6.40
Medium incidence	7	6.02
High incidence	15	7.25
Never Quarantined Producers Favoring Control in:		
Low incidence	9	8.02
Medium incidence	18	6.05
High incidence	16	6.71
Never Quarantined Producers Favoring Eradication in:		
Low incidence	12	7.62
Medium incidence	9	6.00
High incidence	12	8.45
Quarantined Beef Producers Favoring:		
Control	25	6.16
Eradication	19	6.53
Quarantined Dairymen Favoring:		
Control	11	5.55
Eradication	13	6.98

(Sub) Samples	Sample Size	General Attitude Score
Quarantined Beef Producers Favoring Control in:		
Low incidence	6	6.83
Medium incidence	10	5.27
High incidence	9	6.70
Quarantined Dairymen Favoring Control in:		
Low incidence	1	5.00
Medium incidence	5	5.29
High incidence	5	5.91
Quarantined Beef Producers Favoring Eradication in:		
Low incidence	9	6.41
Medium incidence	3	5.14
High incidence	7	7.29
Quarantined Dairymen Favoring Eradication in:		
Low incidence	1	6.29
Medium incidence	4	6.68
High incidence	8	7.21
Never Quarantined Beef Producers Favoring Control in:		
Low incidence	8	8.14
Medium incidence	16	6.17
High incidence	14	6.49
Never Quarantined Dairymen Favoring Control in:		
Low incidence	1	7.00
Medium incidence	2	5.07
High incidence	2	8.21
Never Quarantined Beef Producers Favoring Eradication in:		
Low incidence	7	7.59
Medium incidence	5	6.63
High incidence	4	7.57
Never Quarantined Dairymen Favoring Eradication in:		
Low incidence	5	7.66
Medium incidence	4	5.21
High incidence	8	8.89

Table 6: Prediction of Attitude Toward Brucellosis Program**

Predictor Variables	Beef	Dairy
Discrete Variables		
Incidence level of Brucellosis (geographical area)	*(3.15)	*(12.10)
Control vs. Eradication	*(3.19)	
Experience with Brucellosis (quarantined vs. never quarantined)	*(8.65)	*(7.40)
Discrete Interaction Terms		
Incidence level by experience	*(5.47)	
Control vs. eradication by experience	*(4.37)	
Continuous Variables		
Level of education	-.14(4.15)	
Size of operation (acres)		-.29(14.85)
Level of income	-.18(7.77)	
Prevention knowledge	-.24(12.29)	
Feelings of friends and neighbors toward Brucellosis Program	+.24(11.74)	
Favorability of information sources toward Brucellosis Program	+.17(5.37)	
Overall concern for government	+.17(7.96)	
Federal involvement in Brucellosis Program	-.20(7.86)	-.22(6.47)
Willingness to sacrifice to eradicate Brucellosis		+.53(29.37)
Producer's view of seriousness of Brucellosis		.46(22.54)
Producer's opinion of specifics of Brucellosis Program	-.34(16.61)	-.59(28.36)
R^2 =	72.8	82.3

**Values shown are Standardized Regression Coefficients. A column represents a regression model and within a given model (column) the standardized regression coefficients may be directly compared. The coefficients are not comparable across models (rows). The values in parentheses are partial F values. For significant discrete variables, the standarized regression coefficient has been replaced by an *. Lack of any entry indicates nonsignificance. All values significant at 0.10 level or better.

Annex A

Attitude Scales

General Attitude Toward the Brucellosis Program

I favor the brucellosis program as it is currently run.

I feel the testing aspect of the current brucellosis program works well for all concerned.

I feel the quarantine provisions in the current brucellosis program work well.

I feel the vaccination program as currently recommended works well.

I feel the indemnity aspect of the current brucellosis program works well for all concerned.

I feel that mandatory slaughter of reactor cattle is an essential part of the current brucellosis program.

I believe that a government controlled brucellosis program is needed, but the current one is not working.

Coefficient of Reliability, alpha = 0.74

Beliefs about Brucellosis

It is foolish to spend the time and money needed to comply with government regulations on Brucellosis because there is no effective method of control.

Brucellosis is not a serious enough disease to warrant all the time, effort and money producers spend to comply with the Brucellosis Eradication Program.

I favor a moratorium on the current program and having all the money spent on brucellosis eradication/control put into research on a better identification test and a more effective vaccine.

Due to many inherent problems, the current Brucellosis Eradication Program costs more than the disease, in terms of monetary losses to the producers.

The present Brucellosis Eradication Program is not working and is seen by many producers as a joke.

Many producers are circumventing and violating the Brucellosis Eradication Program requirements.

Brucellosis cannot economically be eradicated.

Brucellosis cannot be economically controlled.

Brucellosis is not really a serious problem in Texas.

I am personally convinced that there is a very great need for a current Brucellosis program.

Controlling brucellosis is important enough to me that I am willing to make some personal sacrifices.

Coefficient of Reliability, alpha = 0.82

Political Outlook

As the federal government is now organized and operated, I think it it incapable of dealing with the crucial problems facing the country today.

These days the federal government is trying to do too many things, including some activities that I do not think it has the right to do, such as the Brucellosis Eradication Program.

As the federal government is now organized and operated, I think it is incapable of dealing with the brucellosis problem.

As the state government is now organized and operated, I think it is incapable of dealing with the brucellosis problem.

These days the state government is trying to do too many things, including some activities that I do not think it has the right to do, such as the Brucellosis Eradication Program.

As the state government is now organized and operated, I think it is incapable of dealing with the crucial problems facing the country today.

Overall, I feel that our government has improved in recent years.

Overall, I have little confidence in our government.

Public officials are usually concerned about what people like me think.

For the most part, the government serves the interest of a few organized groups, such as business or labor, and is not very concerned about the needs of people in agriculture.

People in agriculture have a strong voice about what the government does.

Coefficient of Reliability, alpha = 0.85

Federal Involvement in the Brucellosis Program

As the federal government is now organized and operated, I think it is incapable of dealing with the crucial problems facing the country today.

These days the federal government is trying to do too many things, including some activities that I do not think it has the right to do, such as the Brucellosis Eradication Program.

As the federal government is now organized and operated, I think it is incapable of dealing with the brucellosis problem.

Coefficient of Reliability, alpha = 0.65.

Overall Concern for Government

Overall, I feel that our government has improved in recent years.

Overall, I have little confidence in our government.

Public officials are usually concerned about what people like me think.

Coefficient of Reliability, alpha = 0.58

Concern for Political Power of Agriculture

For the most part, the government serves the interest of a few organized groups, such as business or labor and is not very concerned about the needs of people in agriculture.

People in agriculture have a strong voice about what the government does.

Coefficient of Reliability, alpha = 0.61

Report

National Brucellosis Technical Commission

Appendix D

Retrospective Study of Procedures and Results

of

State-Federal Brucellosis Programs in 12 States

August, 1978

Report

National Brucellosis Technical Commission

R. K. Anderson
David T. Berman
W. T. Berry
John A. Hopkin
Robert Wise

Appendix D

Survey of 12 States

Prepared For

U. S. Animal and Plant Health Inspection Service

and

United States Animal Health Associaton

August 28, 1978

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

This study was conducted by the National Brucellosis Technical Commission which assumes full responsibility for the text of the report, the interpretation of the data, the findings and concludions. However, the study was made possible by the willingness of many people to provide the data which formed the basis of the study.

The Commission wishes to acknowledge the great assistance, personal interest and many hours of effort that went into the retrieval of 22 years of records in each of the cooperating states and in APHIS. In each state and federal office one or more dedicated people gave personal interest and attention to providing the original data and answering follow-up questions by the authors.

We take this opportunity to thank the following individuals and members of their staff who contributed so generously of their time and knowledge to this study.

STATE VETERINARIANS

Alabama	Dr. J.B. Taylor
California	Dr. J.D. Lamont
Florida	Dr. C.L. Campbell
Georgia	Dr. John Kimsey
Louisiana	Dr. F.E. Henderson
Minnesota	Dr. J.G. Flint
Missouri	Dr. T.H. Woods
New York	Dr. H.E. Nadler
North Carolina	Dr. T.F. Zweigart
North Dakota	Dr. D.E. Flagg
Texas	Dr. H.Q. Sibley
Utah	Dr. F.J. Schoenfeld
Wisconsin	Dr. W.E. Lyle

APHIS, USDA

National Brucellosis Program	Dr. Paul Becton
Cattle Diseases	Dr. C.J. Nelson

INTRODUCTION

This study was conducted with the cooperation of appropriate state and federal agencies as part of the work of the National Brucellosis Technical Commission. In planning the work of the Commission, it became evident that certain data essential for evaluation of state brucellosis program procedures and outcomes, were not available in one central place, and had not been previously collected for epidemiologic review and analysis. Therefore, this study was undertaken to provide more appropriate data for analysis of selected state programs.

The data and findings reported in this study of state programs were used by the Commission to supplement other data which have been made available to the Commission such as: Reports of Congressional Committee hearings; Congressional Committee Staff reports; the Proceedings of the Texas A & M University Symposium on Brucellosis; the report of the National Academy of Science, N.R.C. Subcommittee on Brucellosis Research; the public hearings of this Commission; the letters and documents submitted by interested groups and persons; other data collected by this Commission. Readers of this study are referred also to these other documents utilized by the Commission in reviewing and evaluating the brucellosis programs in the U.S. as part of the charge to the Commission.

Purposes of this Study

1. To acquire a data base for analysis of selected state programs from best available state and federal data.

2. To document differences and similarities among 12 state brucellosis programs by examining procedures, activities, expenditures and progress of the programs.

3. To search for differences and similarities among state programs which appear to be associated with a higher or lower prevalence of brucellosis in a state.

4. To evaluate selected program procedures and activities in terms of their epidemiologic significance for effective control leading to local eradication of brucellosis.

METHODS AND PROCEDURES

Data for this study were obtained with the cooperation and assistance of the Brucellosis Committee of the U.S. Animal Health Association, administrators and staff of state animal health agencies, and administrators and staff of federal agencies.

Since it was not feasible to analyze all 50 state brucellosis programs, 12 states were selected initially to represent two groups of states classified as brucellosis "Certified Free" or "Modified Certified Free". Within these two groups, states were selected for characteristic differences and similarities in geographic location, time of program initiation, program procedures, expenditures, cattle populations, etc. For example, Texas, Missouri, Wisconsin, Minnesota and North Carolina are five of the ten states with the largest number of herds of cattle.[1] California and Florida reflect populations with very large dairy herds. North Dakota and California reflect different approaches to mandatory vaccination of calves. Louisiana and East Texas have similarities as well as differences and Texas, west of highway I-35, has marked differences from East Texas and Louisiana. It should be noted that quite often, the differences within states have been greater than differences between states. Prior to the completion of this study, Utah was also asked to assist as a cooperating state.

Data furnished by U.S.D.A.[1,2,27-32] were sent initially to the cooperating states for review with changes or additions. States also provided additional data which had not been available previously in one central place for review and analysis. Because state and federal agencies are required to age their files, much of the data prior to 1970 had been destroyed or placed in relatively inaccessible storage. However, it was possible to obtain some important data back to 1954, and in a few instances some states had special data to 1934. Therefore, this report reflects only the data and years that were still available, most often reflecting the years 1954-1976. Some data were obtained only for the year 1976.

There were many discrepancies in data due to lack of reporting, differences in methods of reporting, lack of data collection, and lack of agreement among the states and the Agriculture Census data which are used to characterize the cattle population in each of the states. This study again shows the need for improved data collection and management systems.

Epidemiologic methods were used, within the limits of available data, for calculating frequency rates to make more appropriate analyses and comparisons among and between states. Temporal data were also used to present data profiles for individual states to illustrate allocation of resources, program activities, and outcomes.

Financial data, both value of production and expenditures, were adjusted and standardized to equal the value of 1976 dollars using appropriate indices.[2]

For purposes of orientation, the following brucellosis program data are presented for each of the cooperating states listed below in rank order according to prevalence of brucellosis reactor herds for 1976 (data from Table 1.2.8B).

States Cooperating in This Study

Name of State	Date of Modified Certification	Years Between Certifications	Date of Certified Free Status	Brucellosis Reactor Herd Rates per 1,000 Cattle Herds at Risk 1976
No. Dakota	1965	5	1970	00.1
Minnesota	1957	13	1970	00.2
No. Carolina	1942	29	1971	00.2
Wisconsin	1956	9	1965	00.2
New York	1959	8	1967	00.4
Utah	1958	6	1964	03.0
California	1962	7	1969	03.4
Missouri	1963	-	----	04.0
Georgia	1959	-	----	10.4
Alabama	1967	-	----	14.7
Florida	1971	-	----	22.5
Texas	1973	-	----	36.2
Louisiana	1970	-	----	39.4

The data presented above should aid the reader in characterizing the status of these several states, as judged by data for years prior to 1977. It should be noted that 1977 and 1978 data have changed the status of nearly all the listed states and this should be considered for any current status judgements.

Dates for gaining status as a "Modified Certified" state cover a period of 31 years, ranging from North Carolina in 1942 to Texas in 1973.

These data show that 3 southern states were "late achievers" and did not complete the requirements for Modified Certified designation until 1970 (Louisiana), 1971 (Florida), and 1973 (Texas). The epidemiologically important points that these data do not show is the length of time elapsing between the complete testing of all cattle in the first and last counties in the state and the opportunities for movement of exposed cattle from noncertified to modified certified counties during the elapsed certifying period. In Florida and Texas, 15 years elapsed between achieving Modified Certified status in the first county and complete testing of all cattle in the last county to be certified.

Such procedures are not epidemiologically valid when one considers that during the 15 year period the original cattle tested had been replaced several times, the cattle population had greatly increased and there were no effective barriers to prevent movement and mixing of cattle between certified and noncertified counties. In addition, during much of this 15 year period there were problems with the surveillance systems in these states. These factors and procedures permitted continu-

ing spread of brucellosis into new herds, making certification of counties under these conditions a delusion and a paper exercise in coloring a map.

The years between modified certification and designation as "Certified Free" ranged from five years for North Dakota to 29 years for North Carolina. Four states which gained designation as "Certified Free" in the least time span (five, seven, eight and nine years respectively) also had high rates of calfhood vaccination, e.g. California, North Dakota, Wisconsin and New York.

FINDINGS AND DISCUSSION

I. Financial Support and Program Costs

A. Total Federal and Non-Federal Expenditures for 12 States

Table 1.1.1 and Figures 1.1.1 and 1.1.2 present a temporal profile of money spent for brucellosis control and eradication programs in 12 states. These data, standardized to 1976 dollar values, indicate that the highest combined state-federal expenditure was $35 million in 1956 followed by a decline to 22 million dollars. Another relative peak of $30 million was reached in 1968 followed by a decrease for the next six years to a low of $22 million in 1974.

Figure 1.1.1 shows that federal funds for these 12 states in 1974 had been reduced to less than 65% of equivalent federal funds spent in 1956 for brucellosis programs. During this period, the reduction in efforts and money to control cattle brucellosis nationally was associated with an increase in cattle herd infection rates between 1972 and 1976 as shown in Table 1.2.7.

The decrease in funding was accompanied not only by an increase in bovine brucellosis, but also by a dramatic increase in human brucellosis. The number of reported human cases in the U.S. nearly doubled, from 175 to 328 reported cases during the period 1973 to 1975.[3] Upon recognizing the increase in bovine brucellosis, program efforts and expenditures were increased in 1976 to $32 million. Since that time additional funds have been allocated toward controlling spread of the disease and reducing brucellosis cases in cattle and people.

B. Indemnity Paid to Owners of Brucellosis Reactor Cattle

Table and Figure 1.1.3 show that peak expenditures of federal funds for indemnity occurred in the years 1955-56 and more recently in 1975-76 to compensate for the loss of brucellosis reactor cattle by the livestock owner, as well as for selective herd depopulation. Since 1972, an increasing percent of federal funds has been allocated to pay indemnity rather than putting these funds into vaccination, efforts to

Table 1.1.1

COMPARISON OF FEDERAL AND NON-FEDERAL FUNDS* ALLOCATED TO BRUCELLOSIS CONTROL FOR 12 SELECTED STATES BY YEAR 1954-1976

	Federal	Non-Federal	Total
1954	$ 2,600,918	$ 11,219,112	$ 13,820,030
1955	14,380,669	10,314,676	24,695,345
1956	18,155,212	16,555,629	34,710,841
1957	13,862,335	13,688,697	27,551,032
1958	13,879,566	13,818,967	27,698,533
1959	12,367,611	14,236,683	26,604,294
1960	10,049,373	11,751,425	21,800,798
1961	12,048,403	15,265,496	27,313,898
1962	11,203,500	15,047,872	26,251,372
1963	11,286,057	15,086,255	26,372,312
1964	12,638,668	15,380,232	28,018,900
1965	12,305,182	15,788,772	28,093,954
1966	11,584,062	15,695,090	27,279,152
1967	12,832,249	16,370,792	29,203,041
1968	13,159,041	16,806,463	29,965,504
1969	11,985,128	17,076,833	29,061,961
1970	11,768,404	16,262,904	28,031,308
1971	9,875,453	14,944,789	24,820,242
1972	9,752,793	14,328,105	24,080,898
1973	9,216,397	13,914,292	23,130,689
1974	8,603,536	13,300,261	21,903,379
1975	12,123,633	15,695,488	27,819,121
1976	15,481,369	16,089,207	31,570,576
TOTAL	$271,159,559	$338,637,769	$609,797,328

*All funds allocated are standardized as 1976 equivalent dollars.

Figure 1.1.1.

Profile of Federal Funds Allocated to 12 States for the Cooperative Brucellosis Program: Comparison of Yearly Funding (1954-1976)

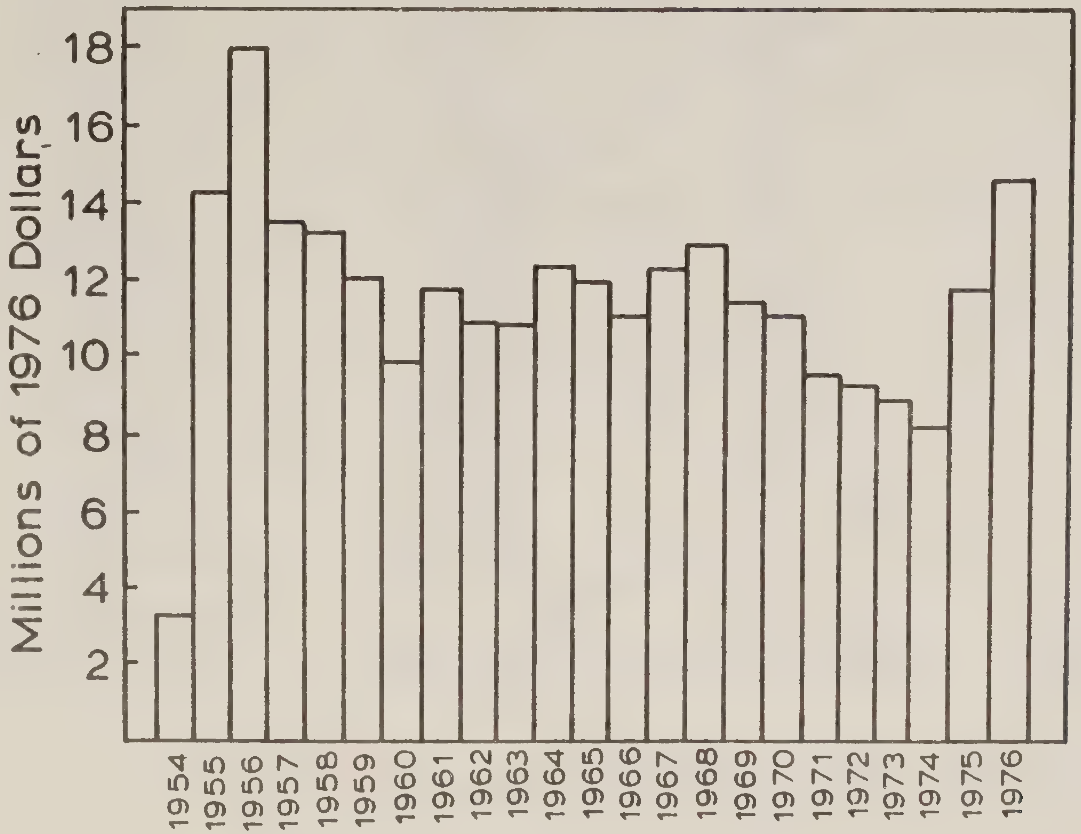


TABLE 1.1.2

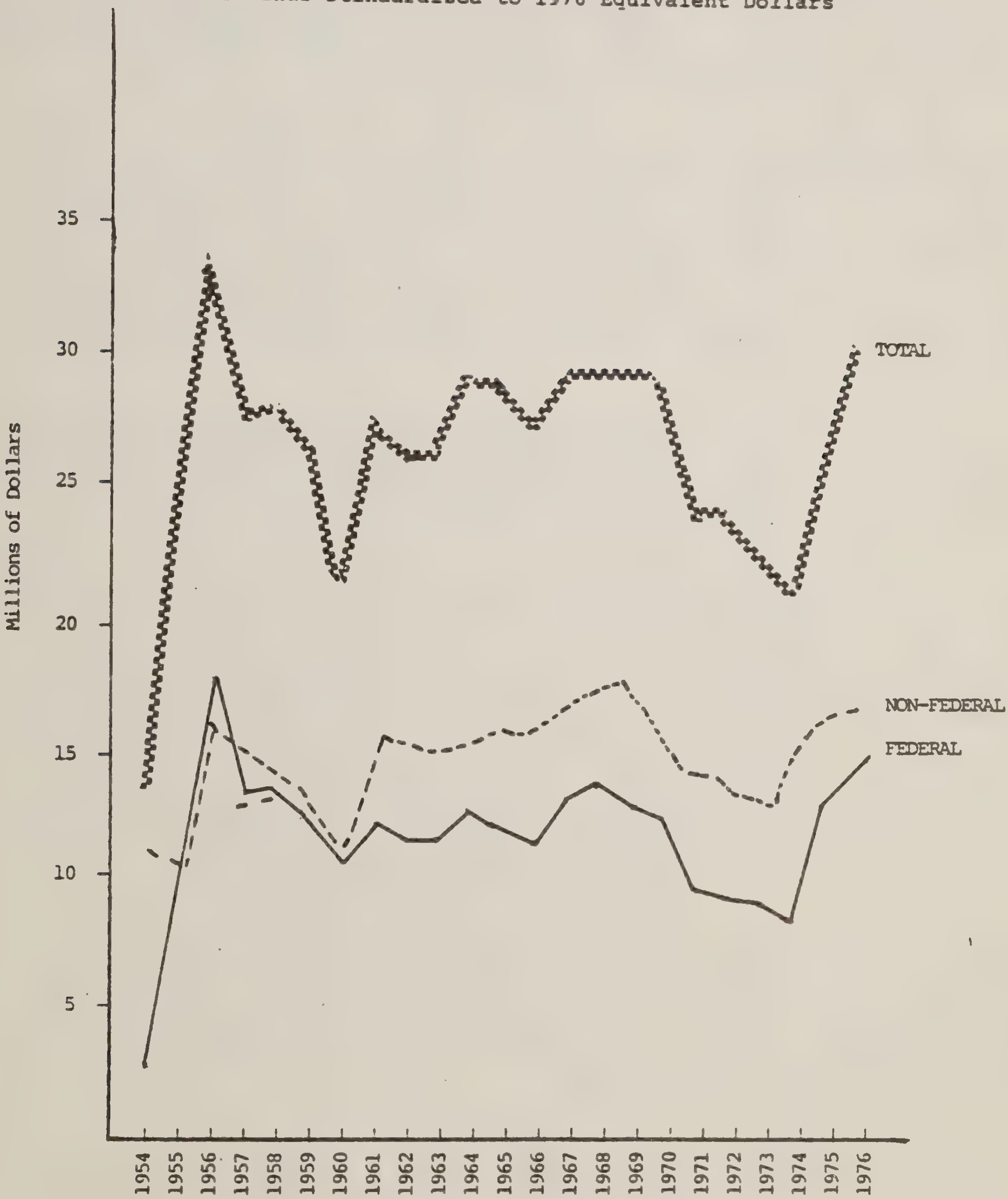
FUNDS OBLIGATED FOR NATIONAL BRUCELLOSIS ERADICATION PROGRAM
IN THE UNITED STATES 1955-77 AND PERCENT (%) ALLOCATED TO 11 HIGHER PREVALENCE STATES

Year	Federal Brucellosis Obligations* for 11 High Incidence States	Federal Brucellosis Obligations* for U.S.	% of Federal Funds to 11 Higher Prevalence States	% of Federal Funds to 39 Lower Prevalence States
1955	$ 8,753,107	$ 35,771,553	24%	76%
1956	11,520,772	46,915,848	25	75
1957	14,909,724	47,394,714	31	69
1958	16,141,475	48,636,767	33	67
1959	13,655,414	43,606,048	31	69
1960	11,055,599	35,387,265	31	69
1961	13,331,211	40,731,114	33	67
1962	13,276,660	40,059,684	33	67
1963	13,488,133	39,780,025	34	66
1964	13,742,991	39,506,181	35	65
1965	14,496,676	40,965,397	35	65
1966	14,583,970	40,245,079	36	64
1967	16,578,407	39,931,256	42	58
1968	17,562,018	39,777,974	44	56
1969	16,155,474	35,940,430	45	55
1970	15,589,248	35,909,921	43	57
1971	13,386,742	26,149,326	51	49
1972	15,231,869	28,131,093	54	46
1973	16,403,566	31,320,715	52	48
1974	16,622,110	32,907,579	51	49
1975	21,231,039	37,106,532	57	43
1976	25,661,950	41,466,138	62	38
1977	26,975,999	44,703,798	60	40

*Standardized to 1976 Equivalent Dollars

Figure 1.1.2

COMPARISON OF FEDERAL AND NON-FEDERAL FUNDS* ALLOCATED TO BRUCELLOSIS CONTROL FOR 12 SELECTED STATES BY YEAR 1954-1976
* All Funds Standardized to 1976 Equivalent Dollars



detect and control new sources of infection, research, or other aspects of the program. Table 1.1.3 shows that actual operating funds continued to decline in 1972 even though total funds increased because indemnity funds were increased from 5% in 1970 to 20% in 1972. Nearly all the increase in total funds was used to increase indemnity from 1.7 million in 1971 to 13 million in 1976, an increase from 5% in 1971 to 35% of total funds in 1976.

Indemnity, appropriately used as one aspect of a program, can help the owner and aid the program. It should be noted that the 50 states have many differences in their policies and indemnity payments as judged by Table 1.1.4 which presents data for 12 states.

For example, Table 1.1.4 shows indemnity payments for a grade dairy cow to range from $5.00 in Georgia, a "Modified Certified" state, to $500 in New York state which is "Certified Free". Two "Certified Free" states, North Carolina and North Dakota paid only $25.00 indemnity in 1976 for a grade dairy cow while Texas, a "Modified Certified" state used no state funds to pay indemnity. All of these indemnity payments by the states depend on state laws and legislative appropriations which vary greatly and may not be associated with the brucellosis status of a given state.

Five of the 12 states may pay indemnity for a calf that is suckling a reactor cow. This has become more of an issue since evidence has been developing that occasionally calves from infected dams may be infected but are not detected until after abortion or calving.

All states except Texas and Louisiana provide state funds together with Federal Funds to pay indemnity when it is judged epidemiologically desirable to depopulate a heavily infected herd to eliminate a source of infection for other herds and thus to prevent spread of brucellosis. It may also be economically advantageous in cases where more money might be spent in retesting over many months than in the indemnity for immediate depopulation. A report from Canada provides a description of their procedures.[5] Depopulation may often be the decision of choice but it should be used along with other alternatives such as whole herd vaccination after careful consideration of both short and long term epidemiologic and economic factors on a herd by herd basis.

These data show: (1) that individual states have individual perceptions of the need for indemnity and the amounts to be paid; (2) that the amount of indemnity paid per cow in each state was not associated with certification status or the rapidity of reduction of the prevalence of brucellosis; (3) that 35% of total federal brucellosis funds in 1976 were allocated to indemnity payments as compared with 5% of total federal brucellosis funds in 1970.

Readers are referred for further discussion and data to: (1) a

Table 1.1.3

Profile of Federal Funds Allocated to National Brucellosis Eradication Program For the Fiscal Years 1954-1976*. Comparison with Indemnity Payments for Each Year.

Year	Total Federal Dollars For Program	Dollars Allocated to Operations Phase of Program	Federal Dollars Paid for Indemnity	Indemnity Paid as % of Total Dollars
1954	$ 7,788,000	$ 6,614,000	$ 1,174,000	15%
1955	32,598,000	22,788,000	9,810,000	30
1956	42,281,000	29,587,000	12,694,000	30
1957	42,472,000	33,527,000	8,945,000	21
1958	43,810,000	36,409,000	7,401,000	17
1959	39,510,000	34,802,000	4,708,000	12
1960	31,993,000	28,854,000	3,139,000	10
1961	36,952,000	33,563,000	3,389,000	9
1962	36,304,000	33,215,000	3,089,000	9
1963	36,013,000	33,400,000	2,613,000	7
1964	35,807,000	33,173,000	2,634,000	7
1965	36,975,000	34,341,000	2,634,000	7
1966	36,108,000	33,800,000	2,308,000	6
1967	35,879,000	33,338,000	2,541,000	7
1968	35,449,000	33,214,000	2,235,000	6
1969	31,857,000	29,801,000	2,056,000	6
1970	31,824,000	29,999,000	1,825,000	5
1971	25,055,000	23,377,000	1,678,000	7
1972	25,226,000	20,171,000	5,055,000	20
1973	27,491,000	22,158,000	5,333,000	19
1974	28,364,000	22,857,000	5,507,000	19
1975	32,556,000	23,720,000	8,836,000	27
1976	$36,834,000	$24,013,000	$12,821,000	35%

* Standardized to 1976 Equivalent Dollars

Figure 1.1.3. Profile of Percent of Federal Brucellosis Funds Allocated to Pay Indemnity to Owners of Brucellosis Reactor Cattle, U.S. 1954-76

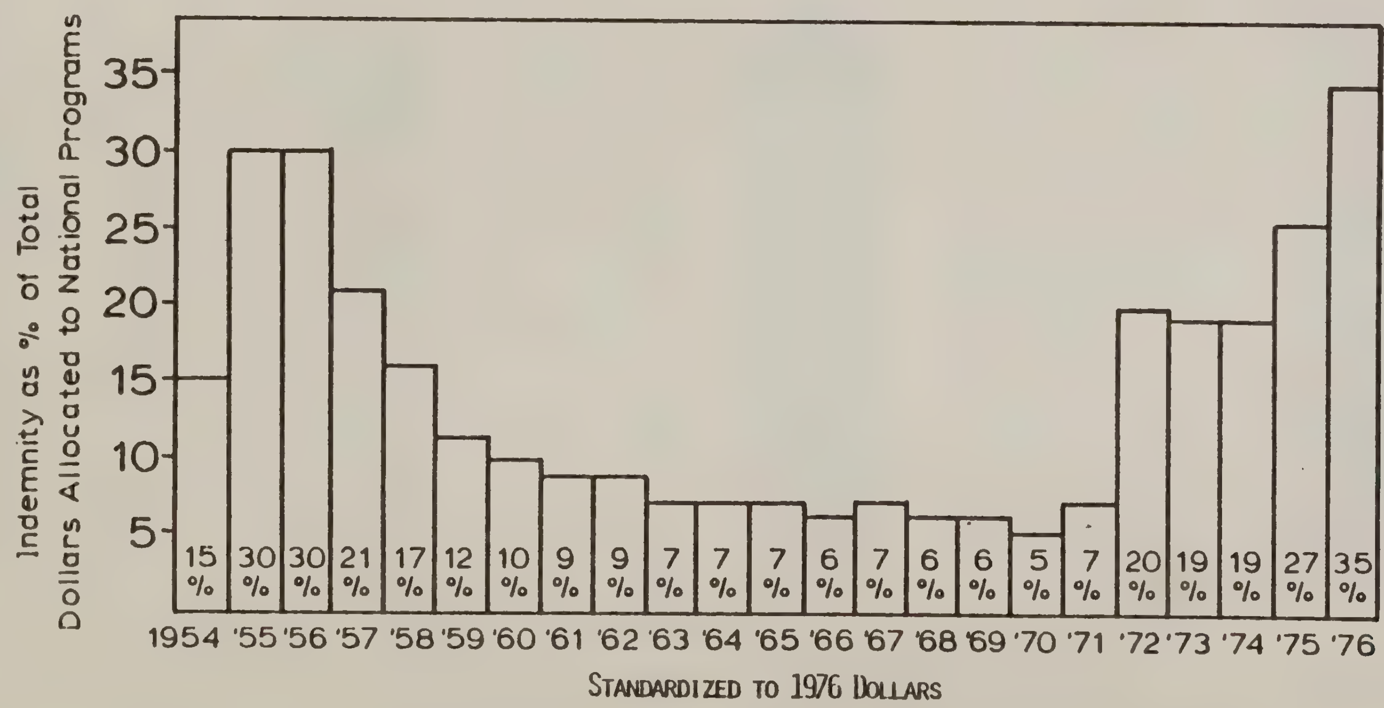


Table 1.1.4

COMPARISON OF INDEMNITY PAID FOR REACTOR CATTLE BY 12 SELECTED STATES (1976 DATA)

Maximum indemnity state is curretly paying owner of a brucellosis infected herd for reactor and exposed cattle and/or calves

	Each dairy cow RX		Each beef cow RX		When herd is depopulated						A calf that is suckling a RX cow:			
					(each cow)		(each heifer)		(each calf)					
State	Grade	Pure Bred	Grade	Pure Bred	Grade	Pure Bred	Grade	Pure Bred	Grade	Pure Bred	Beef Grade	Pure Bred	Dairy Grade	Pure Bred
Alabama**	$ 50	$ 100	$ 50	$ 100	$ 50	$100	$ 50	$100	$ 50	$100	None	None	None	None
California	50	50	50	50	300	400	300	400	300	400	None	None	None	None
Florida**	50	100	50	100	100	100	100	100	100	100	None	None	None	None
Georgia**	5	10	5	10	50	100	50	100	50	100	None	None	None	None
Louisiana**	50	50	None	None	None	None	None	None	None	None	--	--	--	--
Minnesota	50	100	50	100	300	600	300	600	300	600	50	100	50	100
Missouri**	50	100	50	100	40	80	25	50	25	50	25	50	25	50
New York	500	1500	500	1500	90	150	90	150	90	150	None	None	None	None
North Carolina	25	100	25	100	25	100	25	100	25	100	25	100	25	100
North Dakota	25	50	25	50	25	50	25	50	25	50	25	50	25	50
Texas**	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Wisconsin	300	300	300	300	300	300	300	300	300	300	300	300	300	300

-- indicates information not available

** Modified Certified States

Others = Certified Free States

report by Aulaqi and Sundquist[4] which reviews and evaluates methods and concepts concerning indemnification under animal disease control programs; (2) a report which discusses the alternative of "herd depopulation" in Canada.[5] These reports are cited only for purposes of providing material for further discussion and evaluation of these concepts with reference to brucellosis.

C. Percent Non-Federal (State and Industry) Funds for 12 States

Table and Figure 1.2.1 compare total expenditures (federal and non-federal) for brucellosis programs among 12 states. The most total money, standardized to 1976 dollars, has been spent on programs in Wisconsin, $80 million and Texas $75 million, but this does not consider the amount spent per cow (Table 1.2.4) which provides a more meaningful comparison. The lowest percent of federal funding was provided for New York with 18% followed by California and Wisconsin which received only 35% and 40% federal funding respectively for the years 1954-1976. States receiving the largest percent of federal funding include Louisiana 57% and Alabama 59% of total funding.

D. Expenditures Per Dollar of "Value of Production" From Cattle for 13 States

Table 1.2.2 compares total expenditures (federal and non-federal) per dollar of "value of production" from cattle and cattle products, including milk and meat. Five of the six states spending in the range of 29¢ to 98¢ per hundred dollars of value of production 1954-76, were Modified Certified. Six of the seven states spending from 12¢ to 28¢ were Certified Free states.

These data do not reflect the fact that most Certified Free states began their programs early and spent larger sums prior to 1954, which could change their relative position, if expenditures prior to 1954 were included for these "early achievers". On the other hand, the data do reflect the increased spending of the states which were becoming Modified Certified within the last few years. The data also show that as the amount of brucellosis was reduced in early achiever states, their relative rates of expenditures were reduced, as one would expect, while the relative expenditures have been higher in recent years for most of the late achievers, excluding Texas. Texas with more than 5,000 quarantined herds in 1976, spent a yearly average of 17¢ of combined Federal and State money per $100 of value of production from cattle 1954-76 compared to a yearly average of 27¢ for North Dakota, which had only 3 quarantined herds in 1976.

It may also be important to examine more closely why Louisiana and Florida spent 4 to 6 times more than Texas (98¢ and 62¢ vs. 17¢) on their programs. All three states have among the highest rates of brucellosis reactor herds in the U.S. and show no appreciable reduction

Table 1.2.1

COMPARISON OF FEDERAL AND NON-FEDERAL FINANCIAL* SUPPORT
OF THE BRUCELLOSIS PROGRAM AMONG 12 SELECTED STATES
(1954-1976)

State	Federal	Non-Federal	Total	% Federal Funding
New York	$ 7,142,747	$ 33,509,235	$ 40,651,980	18%
California	19,071,532	35,462,772	54,534,304	35%
Wisconsin	31,610,703	48,669,732	80,280,431	39%
Missouri**	24,272,432	37,040,695	61,313,124	40%
North Dakota	9,372,123	12,605,091	21,986,216	43%
North Carolina	7,596,522	9,929,044	17,525,562	43%
Georgia**	21,813,585	27,719,667	49,533,252	44%
Minnesota	26,542,079	29,230,931	55,773,010	48%
Texas**	38,662,877	36,958,060	75,620,937	51%
Florida**	26,552,374	25,398,312	51,950,681	51%
Louisiana**	35,830,423	27,444,996	63,275,421	57%
Alabama**	21,669.623	14,963,509	36,633,132	59%
TOTALS	$270,137,000	$338,932,044	$609,069,064	44%

*Financial support data are standardized to 1976 dollars.

** Modified Certified States

Others = Certified Free States

Figure 1.2.1

COMPARISON OF FEDERAL AND NON-FEDERAL* SUPPORT OF THE BRUCELLOSIS PROGRAM AMONG 12 SELECTED STATES (1954-1976)
*Standardized to 1976 Dollars

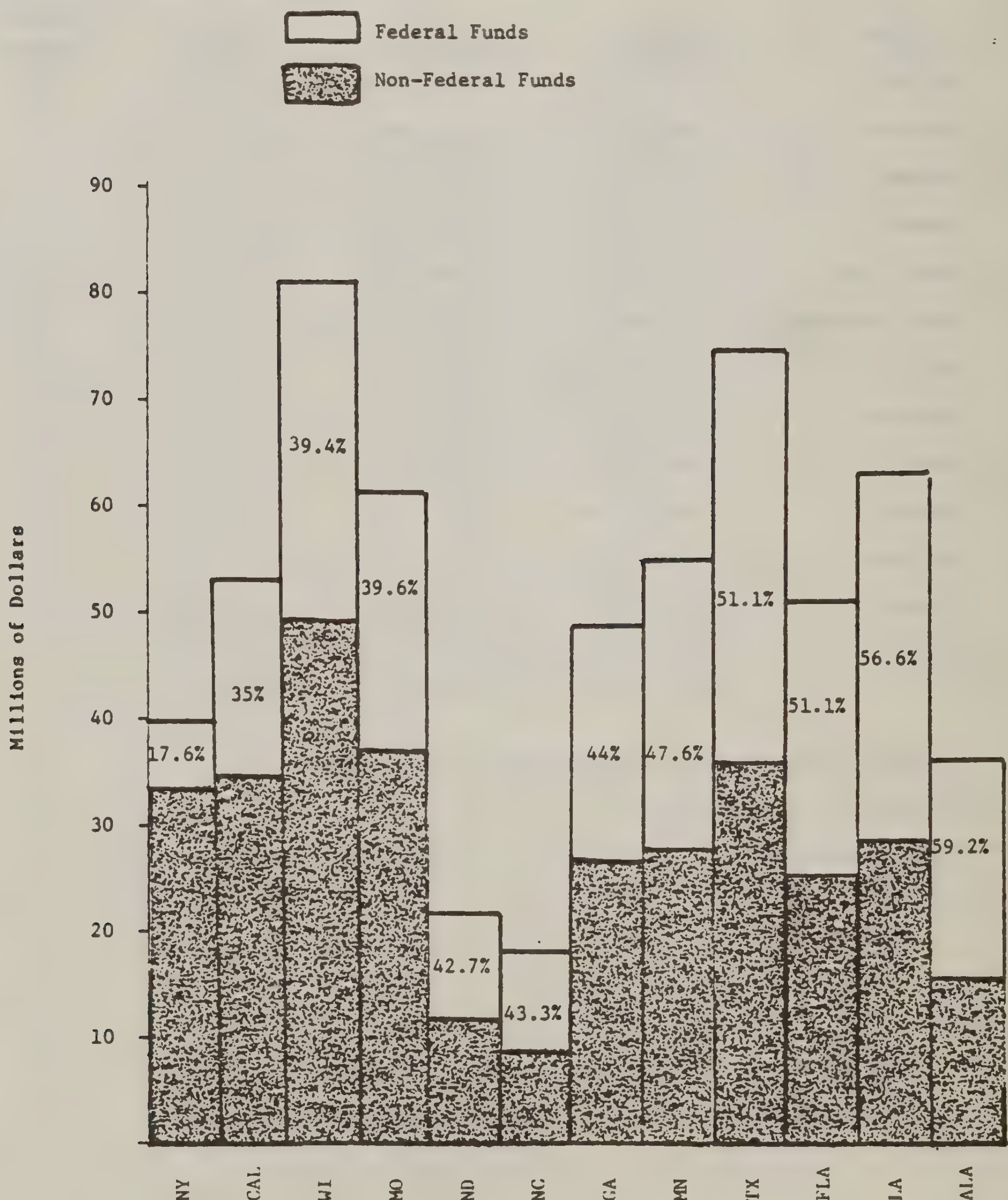


Table 1.2.2

COMPARISON OF AMOUNT SPENT ON BRUCELLOSIS PROGRAM PER HUNDRED DOLLARS OF INCOME FROM CATTLE AND CATTLE PRODUCTS (1954-1976) COMBINED FEDERAL AND NON-FEDERAL EXPENDITURES

State	Gross Income* (1954-76) from Cattle and Cattle Products	Federal and Non-Federal Program Costs* (1954-76)	Amount Spent per Hundred Dollars* of Income from Cattle Products
Louisiana**	$ 6,485,201,000	$63,275,421	98¢
Georgia**	6,413,099,000	49,533,252	77¢
Florida**	8,343,319,000	51,950,681	62¢
Alabama**	6,789,909,000	36,633,132	54¢
Utah	3,770,798,000	11,651,339	30¢
Missouri**	21,257,073,000	61,313,124	29¢
North Carolina	6,211,133,000	17,525,562	28¢
North Dakota	8,254,057,000	21,986,216	27¢
Wisconsin	41,249,335,000	80,280,431	19¢
Minnesota	32,289,872,000	55,773,010	17¢
Texas**	43,354,468,000	75,620,937	17¢
New York	26,298,198,000	40,651,980	15¢
California	$45,123,484,000	$54,534,304	12¢

*Standardized to 1976 dollars.

** Modified Certified States

Others = Certified Free States

in reactor herd rates (Table 1.2.8) since 1967, yet Texas spent only 1/4 to 1/6 of the state-federal funds spent by Florida and Louisiana from 1954-76 (Table 1.2.2).

E. Non-Federal (States and Industry) Expenditures Per Dollar Value of Production From Cattle for 13 States

Table 1.2.2A compares the states in rank order of non-federal funds spent for the brucellosis program 1954-76. Georgia and Louisiana spent 43¢ and 42¢ respectively per $100 of value of production from cattle and cattle products between 1954 and 1976. California and Texas spent 8¢ and 9¢ respectively per $100 of income from cattle and cattle products, but there were large differences in reactor rates among these states.

Examples Using Data From Tables 1.2.2A and 1.2.9

Selected State	Amount Spent Per $100 Income From Cattle	Brucellosis Reactor Rates/1000 Cattle Tested 1946-76
Georgia	43¢	18
Louisiana	42¢	41
Texas	9¢	27
California	8¢	6

These differences in funding appear to reflect wide differences in programs among states. These data indicate that the amount of non-federal expenditures do not necessarily reflect program effectiveness in reducing brucellosis reactor rates. Dollars appear to be a necessary, but certainly not a sufficient, factor for reducing brucellosis reactor rates among cattle. It must also be remembered that the Certified Free States spent large sums prior to 1954 but these are not included in the rankings.

At this time it is not possible to pinpoint the differences between Georgia and Louisiana or California and Texas, but these data provide the basis for asking appropriate questions and analyzing differences in cattle populations, cooperation of owners, program activities, manpower, movement of cattle, density of cattle, vaccination efforts, types of cattle industry, and people factors. Some of these questions are considered in evaluating data provided later in this report.

For example, Table 1.2.2A shows that New York and Wisconsin spent 11¢ and 12¢ respectively per $100 of income during the period 1954-76, but the Table does not include funds spent in the years prior to 1954 when these two states were already heavily involved in the program to meet deadlines imposed by health authorities. Wisconsin people had

Table 1.2.2A

COMPARISON OF AMOUNT SPENT ON BRUCELLOSIS PROGRAM PER HUNDRED DOLLARS OF INCOME FROM CATTLE AND CATTLE PRODUCTS (1954-1976) NON-FEDERAL EXPENDITURES

State	Gross Income* (1954-1976) from Cattle and Cattle Products	Non-Federal Program Costs*	Rank Order of Amount Spent Per Hundred Dollars of Gross Income
Georgia**	$ 6,413,099,000	$27,719,667	43¢
Louisiana**	6,485,201,000	27,444,996	42¢
Florida**	8,343,319,000	25,398,312	30¢
Alabama**	6,789,909,000	14,963,509	22¢
Missouri**	21,257,073,000	37,040,695	17¢
North Carolina	6,211,133,000	9,929,044	16¢
North Dakota	8,254,057,000	12,605,091	15¢
New York	26,298,198,000	33,905,235	12¢
Utah	3,770,798,000	4,351,389	11¢
Wisconsin	41,249,335,000	48,699,732	11¢
Minnesota	32,289,872,000	29,230,931	9¢
Texas**	43,354,468,000	36,958,060	9¢
California	$45,123,484,000	$35,462,772	8¢

*Standardized to 1976 Dollars

** Modified Certified States

Others = Certified Free States

condemned and slaughtered several hundred thousand cattle and vaccinated several million calves prior to 1954 in their efforts to be "Modified Certified" by 1956.

These examples further emphasize the differences among states, and even within states, that need to be continuously studied and reviewed with the aid of an effective data management system to provide both epidemiologic and program data for on-going analyses.

F. Expenditures Related to Total Cow Years (1954-1976)

Table and Figure 1.2.3 show the amount (standardized to 1976 dollars) of non-federal state dollars per total cow years spent on brucellosis programs by the 12 states. Georgia and New York lead the list in having spent \$1.32 and \$1.12 per cow year to conduct their programs from 1954-1976. Texas, which has a relatively high herd prevalence rate, spent the least amount of money per cow year--28¢ and North Dakota which has the lowest rate of herd infection among the 12 states, spent next to the least money--49¢ per cow year.

Table 1.2.3A presents the amount of combined federal and non-federal expenditures per cow year, standardized to 1976 dollars, for each of the selected states as an average for the years 1954 to 1976. The addition of federal funds changes the ranking of five of the states to reflect the increase in federal funds for the Modified Certified states with the higher prevalence of brucellosis. Again, it must be emphasized that reductions in brucellosis are not related solely to amount of expenditures, but appear to be related to how the money is spent and other factors that may be affecting the prevalence of the disease in a state, as shown in Tables and Graphs of each state (see next page).

Figure 1.2.3A compares expenditures of six states. Expenditures for the "Certified Free" states of North Dakota, New York and California decreased in the past ten years as expected but the sharp increase in expenditures for California in 1973-75 and New York in 1975-76 is the result of reintroducing infection through imports of animals from outside the state. This shows clearly the increased costs incurred when infection was reintroduced (Figure 1.2.3A).

Georgia, which began an accelerated program in 1975-76, shows a large increase in expenditures for these years while Texas and Alabama - Modified Certified, higher prevalence states - reduced their expenditures from 1967 and 1969 through 1975. Such a reduction of expenditures in higher prevalence states may have contributed, along with other factors, to increased prevalence of brucellosis.

Profiles of the yearly expenditures of state funds for the brucellosis program are presented as "state-federal dollars expended per cow year" for each of the 12 states from 1954-76 as shown in Tables and Figures 1.64.1, 1.93.1, 1.58.1, 1.57.1, 1.72.1, 1.41.1, 1.43.1, 1.55.1,

Table 1.2.3

COMPARISON OF AMOUNT SPENT ON BRUCELLOSIS PROGRAM
ACCORDING TO TOTAL COW YEARS* AT RISK (1954-1976)
NON-FEDERAL EXPENDITURES

State	Total Cattle Years*	Non-Federal Support +	Rank Order Non-Federal Support Per Cow
Georgia **	20,881,000	$27,719,667	$1.32
New York	29,918,000	33,905,235	1.12
Louisiana **	25,772,000	27,444,006	1.06
Florida **	26,389,000	25,398,312	.96
Wisconsin	55,608,000	48,669,732	.87
California	40,980,000	35,462,772	.86
North Carolina	12,503,000	9,929,044	.79
Minnesota	39,722,000	29,230,931	.73
Missouri **	50,816,000	37,040,695	.72
Alabama **	24,401,000	14,963,509	.61
North Dakota	25,354,000	12,605,091	.49
Texas **	128,179,000	36,958,060	.28

*Total cow years = total cows at risk each year 1954-1976.

+ Non-federal program costs are standardized to 1976 dollars.

** Modified Certified States

Others = Certified Free States

Figure 1.2.3

COMPARISON OF AMOUNT SPENT ON BRUCELLOSIS PROGRAM
ACCORDING TO TOTAL COW YEARS* AT RISK (1954-1976)
NON-FEDERAL** EXPENDITURES

*Total cow years = total cows at risk each year 1954-1976.

**Non-federal support is standardized to 1976 dollars.

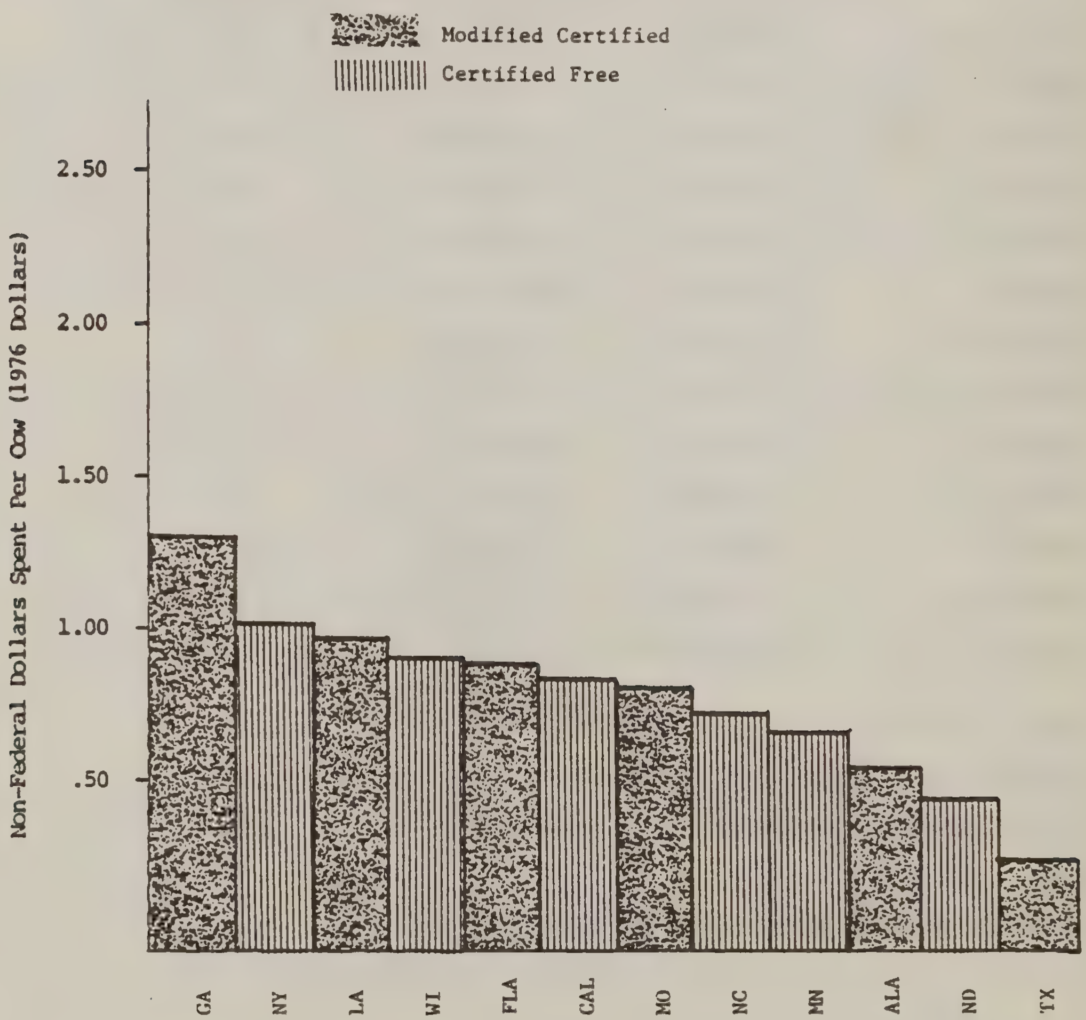


Table 1.2.3A

COMPARISON OF AMOUNT SPENT ON THE BRUCELLOSIS PROGRAM
ACCORDING TO TOTAL COW YEARS AT RISK (1954-1976)
COMBINED FEDERAL AND NON-FEDERAL EXPENDITURES

State	Total Cow Years*	Federal and Non-Federal Program Costs+	Rank Order Amount Spent Per Cow
Louisiana**	25,772,000	$63,275,421	$2.45
Georgia**	20,881,000	49,533,252	2.37
Florida**	26,389,000	51,950,681	1.96
Alabama**	24,401,000	36,633,132	1.50
Wisconsin	55,608,000	80,280,431	1.44
Minnesota	39,722,000	55,773,010	1.40
North Carolina	12,503,000	17,525,562	1.40
New York	29,918,000	40,651,980	1.35
California	40,980,000	54,534,304	1.33
Missouri**	50,816,000	61,313,124	1.20
North Dakota	25,354,000	21,986,216	.86
Utah	17,721,000	11,651,334	.65
Texas**	128,179,000	$75,620,937	$ .59

*Total cow years = total cows at risk each year 1954-1976.

+ Program costs are standardized to 1976 dollars.

** Modified Certified States

Others = Certified Free States

1.45.1, 1.21.1, 1.74.1, and 1.35.1 on pages D83 through D106. The dollar amounts for each of the 12 states have been standardized to reflect 1976 equivalent dollars for each of the 23 years and the % of dollars which were non-federal. By calculating a rate of expenditures based on the number of cows in each state it is possible to make valid comparisons among states whether they have few or many cows in any given year.

Review and evaluation of these profiles lead to several general conclusions:

1. To make sufficient progress toward "local eradication" to be classified as Modified Certified, the majority of these states made a sustained increase in spending for 4 to 6 years. This appears to reflect a sustained motivation and commitment to achieve "Modified Certification", a goal that would be economically beneficial in avoiding some severe restrictions on movement of cattle. Most states achieved the goal following the first 4-6 year sustained, major increase in funding, whether the effort began in 1950 or as late as 1967. For example: Wisconsin made the effort from 1950-56; Texas made a low cost but sustained effort from 1961 to 1971; North Dakota made the effort twice, once from 1953 to 1957 and the second effort from 1961 to 1965 with success; North Carolina succeeded in 1942 but data are not available; New York made the sustained funding increase from 1953 to 1959. Missouri made a big increase from 1956 to 1959 but did not achieve the goal of Modified Certified status until 1963; Minnesota made the big push from 1950-56; Louisiana made a major funding effort from 1955 to 1958 which did not succeed but a second sustained increase from 1967 to 1970 succeeded; Georgia succeeded with an increase in spending from 1955 to 1959; Florida did not really make the push until expenditures were doubled from 1967 through 1971 to reach the goal; California made the sustained, increased effort and expenditures from 1958 through 1962 and Alabama achieved the goal with a major sustained expenditure from 1961 through 1967 to be designated Modified Certified.

2. Once a state had made the sustained major increase in expenditures to achieve the goal of Modified Certified status, expenditures generally declined in all states except North Carolina which made a second major push from 1960 to 1971 to achieve "Certified Free" status. The other 5 Certified Free states achieved this goal without a second major increase in expenditures. This appears to be influenced by the methods of certification which required area testing of counties for Modified Certified status with an accompanying increase in costs, but did not require the same expenditure for Certified Free status if surveillance systems were effective and covering the areas and the cattle adequately.

3. Five of the six Modified Certified states decreased expenditures after reaching this classification. By 1974-75, they were spending only about 1/2 to 1/3 of the non-federal funds spent during the peak

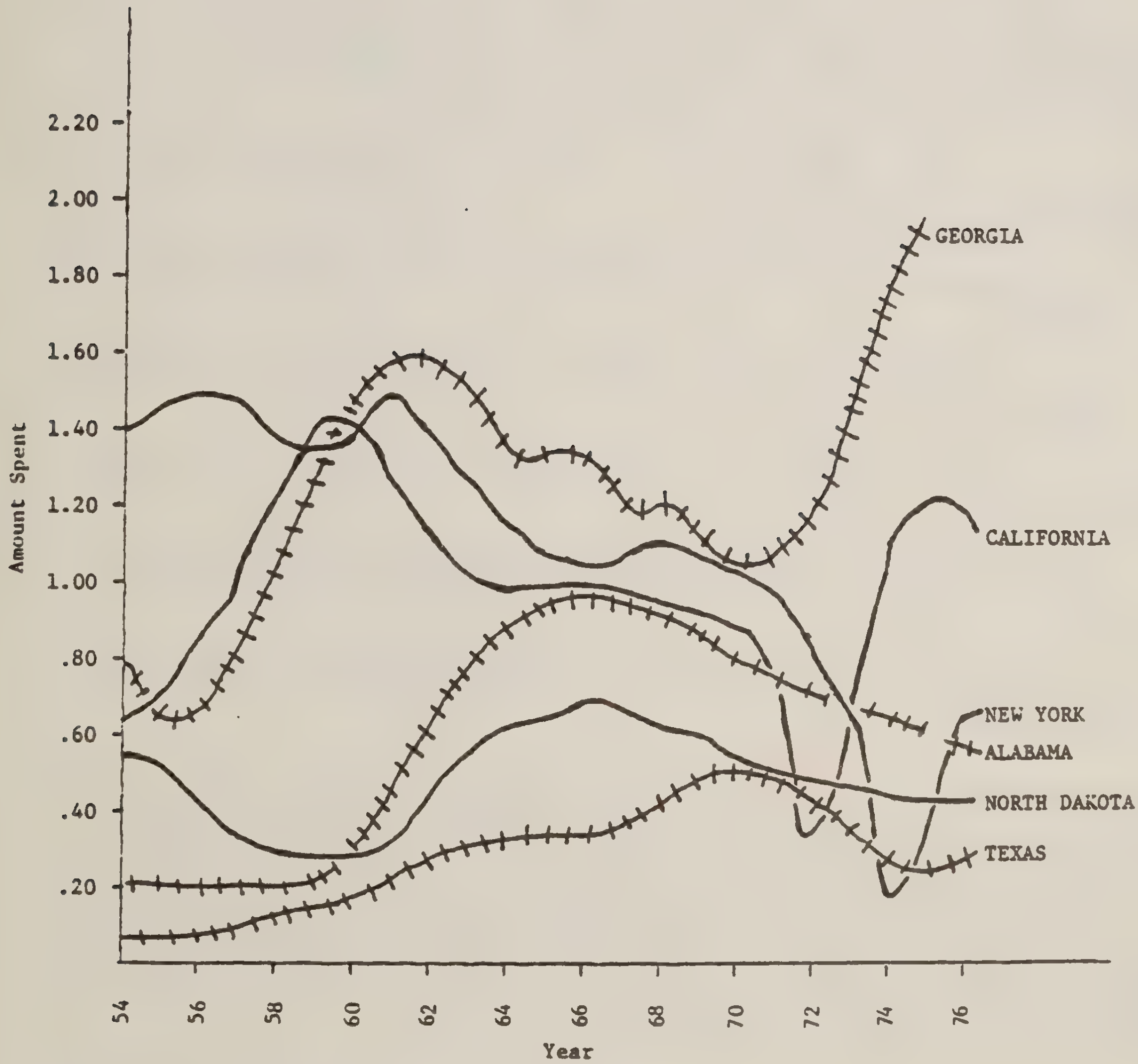
Figure 1.2.3A

PROFILE OF AMOUNT SPENT ON BRUCELLOSIS PROGRAM
ACCORDING TO TOTAL COW YEARS AT RISK (1954-1976)
NON-FEDERAL EXPENDITURES OF SIX STATES

—— Certified Free States

+++ Modified Certified States

SCHEMATIC REPRESENTATION OF DATA



years of 1964-69. This decrease appears to be a complacency or let-down after reaching the goal - "Modified Certified" status - that would avoid the economic penalties of restricting movement. It also was a reflection of a national complacency affecting the whole brucellosis program. Perhaps for some states it reflected a lack of desire to proceed further or a distrust of the program and a belief that the stated goal of eradication could not be reached with the operating conditions of the program in some area of the U.S.

4. Whatever the reasons, there was a significant decrease in funding for the brucellosis program nationally as well as in many of the states. It was not logical however to severely decrease expenditures in areas where prevalence of infection was still relatively high, and cattle populations were expanding and moving from place to place - an ideal situation for spreading brucellosis. However, decreases in funding did occur as shown in the following examples:

Examples of the Decrease in State Funding Among States with Relatively Higher Herd Infection Rates:

Alabama: Non-Federal Funds Spent in 1975 were <u>1/2</u> of the Funds Spent in 1966

Florida: Non-Federal Funds Spent in 1975 were <u>2/3</u> of the Funds Spent in 1967

Louisiana: Non-Federal Funds Spent in 1975 were <u>4/5</u> of the Funds Spent in 1968

Texas: Non-Federal Funds Spent in 1975 were <u>1/2</u> of the Funds Spent in 1969

Missouri: Non-Federal Funds Spent in 1975 were <u>1/3</u> of the Funds Spent in 1966

These data not only indicate a reduction in funds but also reflect reduced manpower to aid owners in finding infection and preventing spread to other herds. As could be expected, reduced funding brought reduced effort and perhaps more significantly, gave higher priority to other diseases and responsibilities. Reduced funding was followed by an increase in animal and human brucellosis during 1973-75. This increase in disease was followed by an increase in funding for the brucellosis program beginning in 1975 in many states.

Table 1.2.4 presents an interesting comparison of state funding in 1976 for brucellosis programs in each state., Many of these states had increased funding in 1975 and 1976 to assist in curtailing the reported increase in brucellosis among cattle and people starting in 1973. Data for Georgia, which spent $2.18 per cow in 1976 are atypical because the

Table 1.2.4

COMPARISON OF DOLLARS SPENT IN 1976 FOR BRUCELLOSIS PROGRAMS
ACCORDING TO COW YEARS AT RISK IN 1976
--- NON-FEDERAL FUNDS (STATE AND INDUSTRY) ---

Name of Participating State	1976 Amount of Money Spent Per Cow
Georgia**	$2.18
Wisconsin	1.10
Florida**	1.08
California	1.03
Louisiana**	1.02
North Carolina	0.87
New York	0.67
Alabama**	0.62
North Dakota	0.46
Missouri**	0.44
Minnesota	0.33
Texas**	$0.32

*Data from Tables 1.64.1, 1.93.1, 1.58.1, 1.57.1, 1.72.1, 1.41.1, 1.43.1, 1.21.1, 1.55.1, 1.45.1, 1.74.1, 1.35.1.

** Modified Certified States
Others = Certified Free States

Table 1.2.4A

RANK ORDER PROFILE OF ANNUAL FINANCIAL SUPPORT** - NON FEDERAL - FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW FOR 12 SELECTED STATES 1954-1976

	GA*	WI	FLA*	CA	LA*	N.C.	N.Y.	ALA.*	N.D.	MO*	MN	TX*
1954	$ .77	$1.02	$ .19	$ .61	$ .39	$ .65	$1.43	$ .22	$ .50	$ .22	$1.33	$ .02
1955	.41	1.01	.25	.57	.47	.34	1.42	.18	.46	.12	1.12	.02
1956	.50	2.16	.56	.41	2.40	.30	1.60	.17	.36	.75	.86	.02
1957	.99	1.03	.53	.41	2.36	.44	1.46	.19	.35	.74	.70	.02
1958	1.54	.92	.71	.86	1.51	.44	1.38	.18	.36	1.06	.55	.05
1959	1.54	.91	.59	1.62	.60	.43	1.57	.18	.26	1.18	.52	.05
1960	1.50	.65	.68	1.13	.69	.73	1.22	.26	.25	.66	.65	.11
1961	1.81	.62	.86	1.24	.71	.96	.99	1.03	.64	1.11	1.03	.22
1962	1.46	.71	.84	.93	.81	1.00	1.26	.60	.64	.93	.91	.33
1963	1.43	.67	.91	.93	.79	1.14	1.08	.79	.65	.84	.79	.39
1964	1.12	.78	.83	1.01	.84	1.12	.99	.92	.76	.72	.87	.34
1965	1.40	.75	.80	1.03	.88	1.19	1.05	.91	.65	.94	.76	.32
1966	1.14	.86	.79	.96	.90	1.15	1.01	.97	.64	.97	.73	.33
1967	1.24	.63	1.52	.91	1.17	1.11	1.14	.90	.64	.83	.57	.46
1968	.93	.69	1.49	.83	1.28	1.04	1.06	.81	.55	.88	.83	.54
1969	1.38	.83	1.29	.82	1.21	.87	1.00	.73	.49	.89	.61	.61
1970	1.38	.94	1.32	.84	1.02	.86	.91	.79	.44	.78	.64	.51
1971	.88	1.20	1.31	.48	1.03	.89	.93	.85	.44	.86	.63	.40
1972	1.37	.96	1.35	.41	1.06	.86	.86	.80	.49	.88	.56	.31
1973	1.30	.93	1.33	.52	1.04	.76	.80	.75	.45	.74	.53	.25
1974	1.38	.95	1.10	.89	1.00	.66	.22	.63	.37	.30	.57	.30
1975	2.22	.96	1.01	1.25	.99	.59	.69	.57	.45	.33	.51	.26
1976	2.17	1.10	1.08	1.03	1.02	.87	.67	.62	.46	.44	.33	.32

*Modified Certified States
**Standardized to 1976 Dollars

increase is related to initiation of an accelerated program in Georgia. Other states appear to pair off in their spending for brucellosis control in 1976, without regard to amount of infection in the state.

Examples

Non-Federal Funds for 1976

Modified Certified tates*	Amount Spent Per Cow Year	Certified Free States
Florida*	$1.08 vs $1.10	Wisconsin
Louisiana*	1.02 vs 1.03	California
Alabama*	0.62 vs 0.67	New York
Missouri*	0.44 vs 0.46	North Dakota
Texas*	$0.32 vs $0.33	Minnesota

(From Table 1.2.4)

These examples show that non-federal funds spent per cow year were similar in Wisconsin, a Certified Free state, when compared to Florida which had 22 brucellosis reactor herds per 1,000 herds in the population; California, a Certified Free state was similar in spending to Louisiana which had 39 brucellosis reactor herds per 1,000 herds in the population; Minnesota, a Certified Free state was similar, in non-federal expenditures for brucellosis, to Texas which had 36 brucellosis reactor herds per 1,000 herds in the population in 1976 (Table 1.2.8B).

On the other hand it is important to note that expenditures for Certified Free states did decrease after they achieved reduced levels of brucellosis infection and became Certified Free. For example: Minnesota expenditures decreased from a high of $1.54 in 1954 to only 33¢ in 1976; New York expenditures decreased from a high of $1.60 per cow to a low of 22¢ per cow in 1974 prior to reintroduction of infection from outside the state; California decreased from a high yearly expenditure of $1.62 in 1959 to a low of 41¢ per cow in 1972 prior to reintroduction of brucellosis infection from outside the state as shown in Tables and Figures 1.64.1, 1.93.1, 1.58.1, 1.57.1, 1.72.1, 1.41.1, 1.43.1, 1.55.1, 1.45.1, 1.21.1, 1.74.1 and 1.35.1 on pages D83 through D106.

Although the costs of brucellosis programs were reduced in states as they achieved freedom from brucellosis, the constant threat of reintroduction or the actual reintroduction of brucellosis from higher prevalence areas has forced Certified Free states to maintain a higher than normal level of surveillance costs, or when reintroduction does occur, make a sharp increase in spending as in New York and California (Figure 1.2.3A).

Table 1.2.4 shows that six Certified Free states with very few

infected herds spent more per cow in 1976 to protect their cattle industry from infection that may be introduced from outside the state than was spent by Texas which had more than 5,000 known brucellosis reactor herds in 1976, as well as additional unknown infected herds that could serve as reservoirs and sources of infection within the state, as well as for other states. The previous Table 1.2.3 and figures 1.2.3 and 1.2.3A show that Texas has spent the least money per cow per year of any of the 12 states in this study, although reporting the second highest rate of brucellosis reactor herds per 1,000 herds in the population in 1976.

II. Observations on Strain 19 Vaccination of Calves

Since 1946, Strain 19 *Brucella abortus* vaccine has been available for vaccination of calves and many herd owners have found it to be a useful adjunct to herd management in reducing infection in a herd to provide a useful level of protection for cattle exposed to *Brucella abortus*.

To encourage vaccination many states adopted one or more of several incentives:

1. state agencies provided education of owners to vaccinate calves as a self interest with no financial subsidy

2. state agencies provided vaccine free of charge to veterinarians who did not charge owners for the vaccine

3. state agencies provided vaccine and paid veterinarians on a fee basis to vaccinate calves without charge to the owners

4. state law provided some form of mandatory vaccination.

Tables and figures 1.64.2, 1.93.2, 1.58.2, 1.57.2, 1.72.2, 1.41.2, 1.43.2, 1.55.2, 1.45.2, 1.21.2, 1.72.2, and 1.35.2 on pages D107 through D130, provide a tabular and graphic profile showing the percent of female calves vaccinated in each of these states for each year 1954-1976. At the top of each graph, symbols indicate the years in which the various incentives were offered to owners to encourage calf vaccination and these are correlated in time with percent of vaccination to show effect of incentives on the number of calves vaccinated each year.

A. Recommendations of Committee of Consultants, 1956

In 1956 a Committee of Consultants[6] was appointed by the Secretary of Agriculture to review the Brucellosis Program of U.S.D.A. and to make recommendations. As part of their report they stated:

"It is our opinion, in fact, that calfhood vaccination should be recommended in all regions in which any infection is known to exist until the time is reached when all infection has been stamped out. It is the surest way to prevent extensive and disastrous "breaks". Vaccination should not be discontinued until brucellosis caused by Br. abortus no longer exists in our cattle. When that time is reached, we can discontinue it and pack the disease away in our history books providing we then establish very rigid import regulations to prevent the re-entry of the disease from abroad."

In reviewing the data for the 13 states in this study, it becomes obvious that most states and the U.S.D.A. did not accept this advice in 1956, nor follow it during the following 20 years to 1976. Examples that follow are drawn from the data submitted by state and federal agencies.

B. Mandatory Vaccination:

1. In 1948 California (Table and figure 1.93.2) pages began a mandatory vaccination program for dairy calves, a voluntary vaccination program for beef calves and declared a moratorium on blood testing until October 1957. According to Stuart et al.,[7] it was a very difficult task to maintain a high level of vaccination but, after 11 years of vaccination, the infection rates for dairy cattle were reduced from 18% to 2% infection and in beef cattle, infection was reduced from 9% to less than 1% by vaccination alone. In 1957, eradication measures were added to the program and serologic testing with disposal of reactor animals became compulsory. In 1961, the control measures were further tightened and cattle imported from out of state for use as dairy replacement animals were required to be vaccinated. California achieved "Modified Certified" status in 1962 and "Certified Free" status in 1969. California had a herd infection rate that increased from 1/1000 in 1972 to a rate of 4/1000 in 1976, but this higher rate was a direct result of importing infected cows from other higher incidence states. California officials have data to show that vaccination does assist importing herds to resist infection and that importing herds need protection.[21]

2. Table and figure 1.45.2 pages D125 & D126, show that prior to 1962 North Dakota encouraged vaccination by paying for the vaccine and its free administration. In 1962 this free vaccination discontinued and mandatory owner financed vaccination of all calves being sold for breeding was instituted. With the mandatory vaccination law, 34% to 52% of the female calves were vaccinated each year 1962-1976, one of the best vaccination records among the 13 states (Table 1.45.2). North Dakota which became "Modified Certified" in 1965 and "Certified Free" in 1970, had a herd infection rate of 0.1/1000 herds in 1976.

In 1973 the law, requiring Strain 19 vaccination of calves, sold within North Dakota, was repealed because: (1) the state was "Certified Free" of bovine brucellosis and (2) the problems of over-age vaccination of calves and persisting serologic titers were thought to be greater than the need for protection engendered by vaccine, at this time, in this state.

California and North Dakota now have opposite views and policies on vaccination because their problems are different. California has a need to protect against infected imports while North Dakota is primarily an exporter of cattle. This illustrates why flexibility is needed in all phases of the program.

C. No Incentives for Vaccination

Table and Figure 1.41.2 pages D117 & D118, show that Minnesota cattlemen vaccinated between 16% and 27% of the female calves as a matter of self interest and without any subsidies or incentives from state or federal governments. Cattle owners used their own judgment about vaccinating and paid their own costs without assistance. Perhaps this is one reason the vaccination level in Minnesota remained relatively constant between 1958 and 1973 when other states were affected by the 1968 change in federal policy. Without vaccination incentives and with only about 25% vaccination, Minnesota became "Modified Certified" in 1957 and "Certified Free" in 1970.

D. Incentives and Voluntary Vaccination

Tables and Figures 1.64.2 pages D107 & D108 Alabama, 1.58.2 pages D111 & D112 Florida, 1.74.2 pages D127 & D128 Texas, 1.35.2 pages D129 & D130 Wisconsin and 1.21.2 pages D121 & D122 New York are examples of states which encouraged voluntary vaccination with education and several types of incentives. New York also required prior calfhood vaccination of calves and heifers imported into the state from 1956-1967.

Wisconsin provides an excellent example of a state which used various incentives at different stages in the conduct of its program. Already in 1948, through combinations of county or township plans with state-federal payment or individual herd certification programs without subsidy, calfhood vaccination levels of 20-30% were being achieved. In 1951, with the impetus provided by the brucellosis requirements of the Chicago Board of Health, state legislation was passed which put all herds in the state under some form of control status. All infected herds were required to practice calfhood vaccination, as well as to remove reactors, to be eligible to remain under plan A. In infected herds under plan B, calfhood vaccination was also mandatory. With a massive educational campaign as well as the incentive of free vaccine, freely administered, and always backed up by the Chicago Board of Health clean-up deadline, the program moved rapidly. In fiscal year, 1951-52,

544,676 calves, an estimated 90% of replacement calves, were vaccinated with strain 19, and that level continued through 1956, when the state was declared Modified Certified.[8] Thus, when the data summarized here began, more than half of the breeding cows in the state had been vaccinated as calves, and more than 185,000 reactors had been slaughtered under the program. Vaccination levels continued at 45-52% under the voluntary program with free vaccine and its free administration until 1969, because Wisconsin producers, their veterinary advisors and the state regulatory officials were all convinced that they faced substantial risk of reintroduction from outside the state, and because officially vaccinated heifers commanded a premium in such states as California. Wisconsin became "Modified Certified" in 1956, "Certified Free" in 1965. The prevalence rate for herd infection was 0.23/1000 herds in 1976.

E. Comparison of Vaccination Strategies in 12 States

1. Table 1.2.5 compares percent of vaccination of female calves among 12 states for the years 1954-76. Five of the six Modified Certified states, with higher prevalence rates of brucellosis (indicated by **), vaccinated an average of less than 4% of female calves from 1970-76. In contrast five of the six Certified Free states, with lower prevalence rates of brucellosis, vaccinated an average of more than 30% of female calves from 1970-76. Two exceptions were: (1) Florida a Modified Certified state that vaccinated an average of 14% of female calves about the same as New York, a Certified Free state and (2) North Carolina a Certified Free state which never vaccinated more than 14% in a given year and vaccinated only an average 1% of female calves from 1970 to 1976 which is about the same as Alabama, a Modified Certified state, from 1970-76. Thus in general the Certified Free states had higher vaccination rates for the 23 years 1954-76 and maintained higher rates particularly from 1970-76.

California and North Dakota with mandatory vaccination laws achieved and maintained the highest percent vaccination --- 35-55%.

States which had voluntary vaccination encouraged by free vaccination ranged from a high of 30-40% vaccination of female calves in Florida and Missouri to states with maximum percentages of vaccination of calves of 19% in Texas and 25% in Georgia in 1963. Vaccination rates for female calves in Texas, even with the subsidy of free vaccination, were less than 15% except in 1963 and 1964 and were the lowest vaccination rates for the years 1954 to 1970 of any of the six selected Modified Certified higher prevalence states.

Table and Figure 1.43.2 for the state of Missouri pages show how dramatically vaccination rates can decrease from 38% in 1965 to 7% in 1970. In 1965 state and federal officials began discouraging the motivation for vaccination and then in 1968 discontinued paying for vaccine and vaccination.

Table 1.2.5

COMPARISON OF CALFHOOD VACCINATION WITH STRAIN 19 VACCINE BASED ON PERCENT VACCINATION OF FEMALE CALVES EACH YEAR 1954-1976 FOR 12 SELECTED STATES

Percent of Calves Vaccinated for Brucellosis

Year	CAL	ND	WI	MN	FLA **	NY	TX **	CA **	LA **	MO **	NC	ALA **
1954	50.1	9.1	39.3	16.5	21.7	45.9	1.6	5.7	16.6	8.9	.68	13.9
1955	46.1	13.5	39.9	16.7	37.8	40.1	3.2	9.8	17.9	14.3	.82	12.4
1956	45.6	15.1	44.9	17.1	18.9	45.5	4.4	10.3	20.6	22.9	1.0	15.3
1957	46.3	23.6	40.3	20.3	-	40.0	7,0	12.3	21.7	29.1	1.4	17.8
1958	53.0	35.0	45.7	23.3	31.1	42.6	8.9	16.3	24.7	38.2	2.1	14.3
1959	58.3	38.2	51.3	25.2	32.8	47.5	11.5	20.2	24.7	38.1	3.5	17.8
1960	58.3	38.1	50.6	25.9	35.6	49.3	12.5	23.7	26.2	37.2	5.1	18.7
1961	51.7	47.6	49.4	27.0	31.2	52.5	14.2	21.5	29.5	34.3	7.4	21.0
1962	50.6	48.1	45.7	26.2	31.6	49,4	14.6	22.9	30,2	35.2	8.5	26.1
1963	49.5	54.0	52.0	24.4	37.5	45.1	19.1	25.6	30.7	37.7	10.8	27.3
1964	54.3	50.5	46.1	24.0	39.0	40.6	16.1	19.7	23.5	37.5	11.8	25.7
1965	52.0	47.0	47.4	23.8	35.1	42.0	13.2	10.4	21.7	38.4	13.6	29.4
1966	49.5	49.1	45.0	23.9	35.1	40.9	11.1	10.6	19.2	27.6	12.6	26.6
1967	48.3	52.4	44.2	24.3	36.7	42.7	12.8	11.6	2017	34.7	10.7	24.4
1968	54.1	43.8	46.8	23.9	30.3	25.7	10.5	10.5	18.9	29.2	5.7	20.0
1969	46.3	34.9	46.2	22.7	28.8	40.0	7.9	7.1	15.7	21.7	2.3	6.9
1970	48.6	38.3	36.1	23.1	23.6	37.0	6.7	5.3	10.0	7.1	2.1	2.2
1971	35.0	40.3	36.7	22.6	20.0	32.8	6.2	5.3	10.0	5.0	1.2	1.4
1972	41.1	52.1	31.5	22.2	18.3	21.1	5.8	4.2	5.6	4.2	1.1	1.0
1973	34.4	50.2	27.6	22.0	11.1	9.5	5.1	3.6	3.0	2.6	1.0	.6
1974	32.6	42.3	21.3	22.2	7.2	9.5	6.6	3.3	2.4	1.4	.9	.5
1975	36.6	33.8	26.8	17.3	8.0	10.8	5.2	3.5	2.3	1.9	1.0	,6
1976	46.3	35.4	27.2	17.5	12,2	10.7	5.1	3.3	2.7	1.7	.9	.7

*Ranked by 1976 Vaccination Level ** Modified Certified States Others = Certified Free States

North Carolina and Minnesota, Certified Free states, did not encourage vaccination of calves and did not pay for vaccine or vaccine administration. North Carolina cattlemen vaccinated a maximum of 14% of female calves in 1965 and had an average of only 1% vaccination of calves from 1970-76. Minnesota cattlemen vaccinated a minimum of 16% in 1954, a maximum of 27% in 1961 and maintained an average of more than 20% vaccination from 1970-76. Minnesota owners, who had no free vaccine and no free vaccination, vaccinated a higher percentage of female calves from 1954-76 than the cattle owners of either Alabama or Texas where free vaccine and free vaccination were provided to promote vaccination of female calves.

These data demonstrate (1) that in general terms a higher percentage of vaccination of calves was associated with the "Certified Free" states which have a lower prevalence of brucellosis, (2) that no one plan for vaccination is a panacea, (3) that motivation of owners for vaccination and their own decision making is equally as important as providing free vaccine and free vaccination of calves.

2. Tables and Figures 1.2.5 and 1.2.5A show that vaccination rates for calves began decreasing in some states up to five years before the 1968 date when U.S.D.A. stopped paying for the administration of vaccine.

Examples of When Vaccination Decreased

Date When Percent Vaccination of Calves Started to Decrease	Name of State	Date State Stopped Payments for Administering Vaccine
1962	Texas	1972
1963	Louisiana	1967
1963	Georgia	Not available
1964	Florida	1971
1965	Alabama	1968
1965	North Carolina	1965
1966	Missouri	1968
1967	New York	1972
1968	California	1971
1969	Wisconsin	1969
1972	North Dakota	1963*
1973	Minnesota	Owner Paid

*North Dakota passed a law in 1963 requiring vaccination of all calves being sold. At the same time the state stopped free vaccination and made the owners pay for vaccination but % vaccination increased.

Many cattlemen and veterinarians have stated that the U.S.D.A. decision to stop paying veterinarians for administering vaccine in 1968 caused

Figure 1.2.5.

Percent of Female Calves Vaccinated for Brucellosis as Related to Vaccination Subsidies, Mandatory Vaccination and Prevalence of Brucellosis

↓ Vaccination Decline Begins

o-o-o-o Mandatory Dairy Calf Vaccination

- - - - Vaccination Paid by State/Federal Funds

—— Vaccination Not Mandatory-Paid by Owner

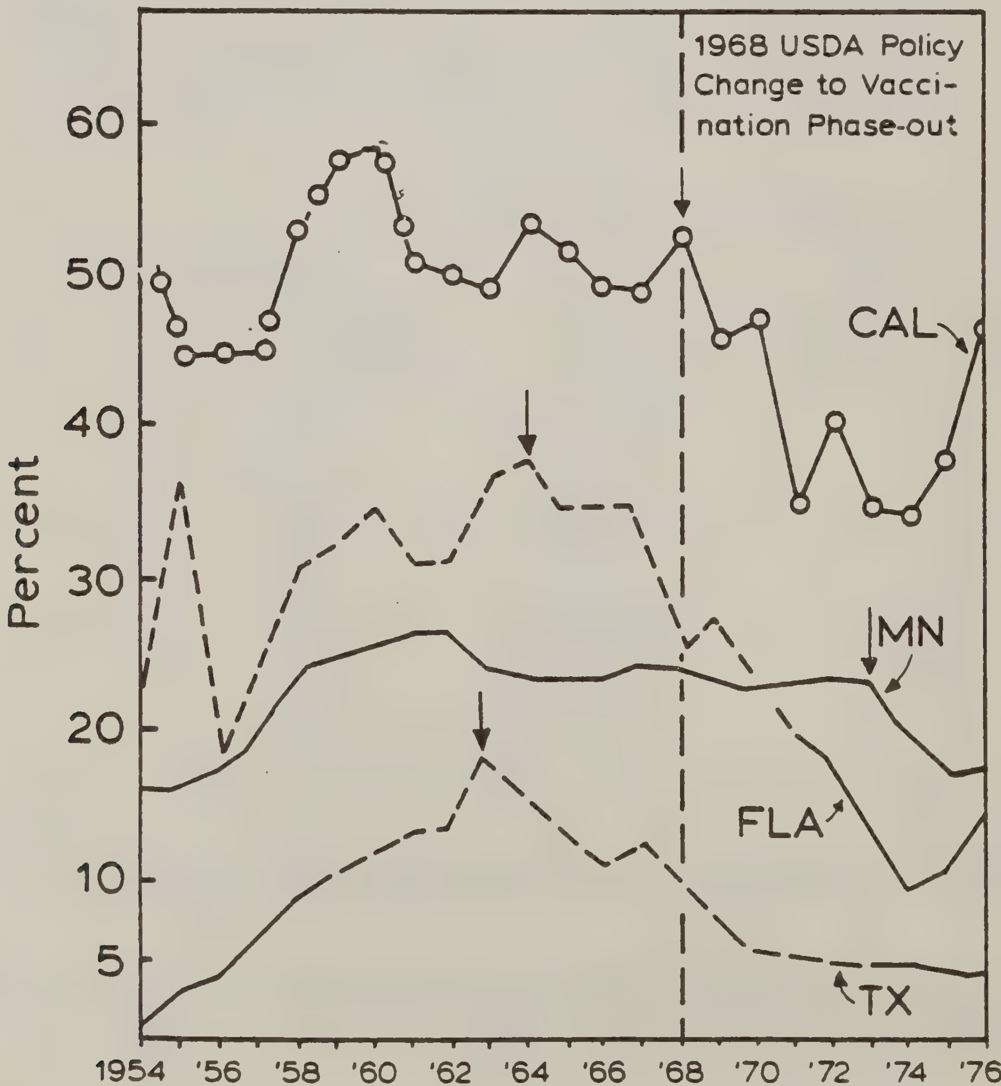
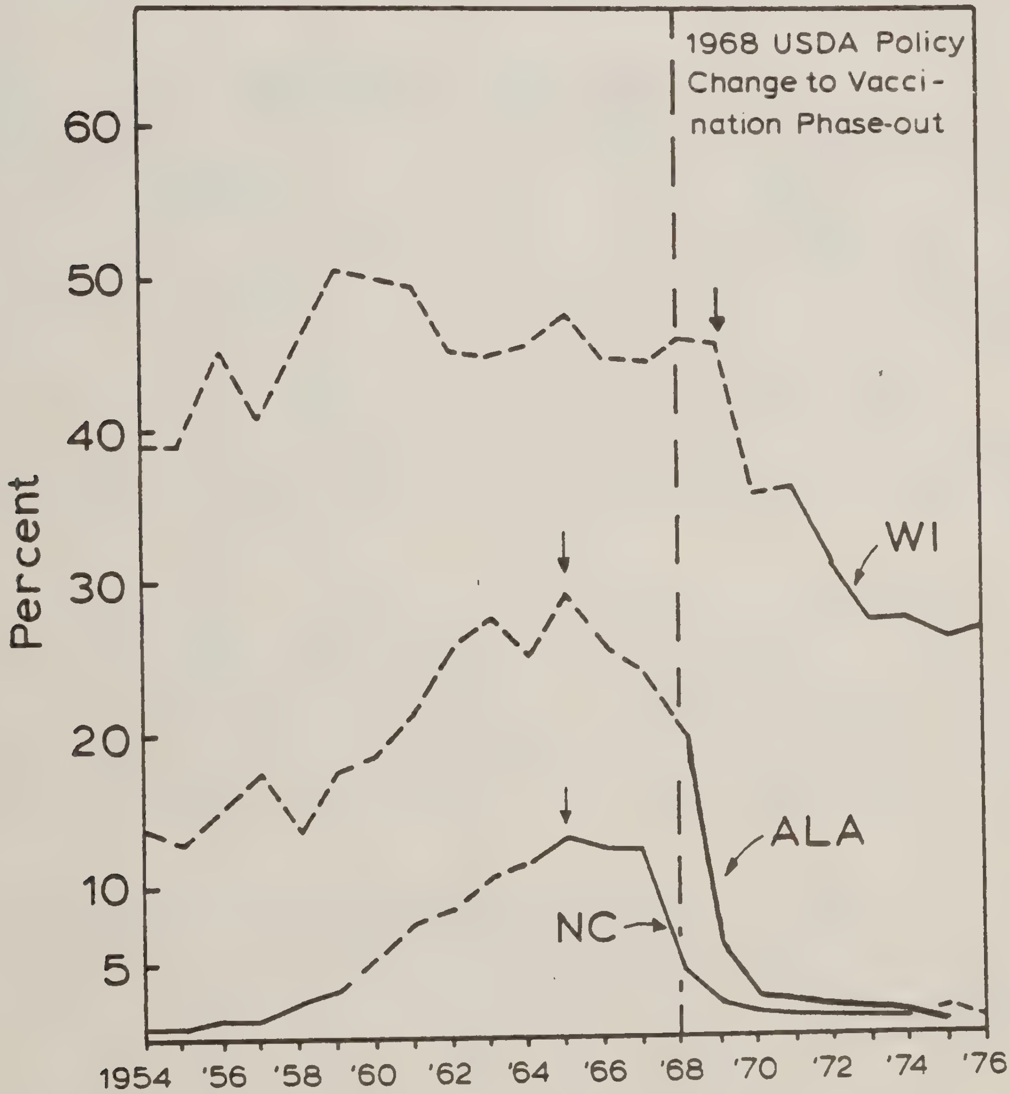


Figure 1.2.5A

Percent of Female Calves Vaccinated for Brucellosis as Related to Vaccination Subsidies, Mandatory Vaccination and Prevalence of Brucellosis

↓ Vaccination Decline Begins
----- Vaccination Paid by State/Federal Funds
——— Vaccination Paid by Owner



owners to stop vaccinating. These data from Tables 1.64.2, 1.93.2, 1.58.2, 1.57.2, 1.72.2, 1.41.2, 1.43.2, 1.21.2, 1.55.2, 1.45.2, 1.74.2, and 1.35.2 pages D107 through D130, should demonstrate that many cattle owners began to discontinue vaccination as early as 1962. For example, in Texas the percentage of calves vaccinated decreased from the high of 19% in 1962 to 16% in 1963 and 14% in 1964. The data in Table and Figure 1.74.2 pages D127 & D130 indicate that Texas cattle owners reported vaccination of an average of 9% of female calves between 1954 and 1976 although free vaccination was officially available up to 1972.

3. Vaccination percentages and the decrease in vaccination for states such as Alabama, Texas and North Carolina prior to the U.S.D.A. policy change may have been influenced by a number of factors, several of which are discussed below:

(a) The disadvantages of vaccination, particularly with regard to persisting post-vaccinal titers may have been a factor in decreasing vaccination in some areas of the country. Although Mingle,[9] said, "....make haste slowly and carefully in deemphasizing vaccination", some people had begun to generate apprehensions, as early as 1963, about "problems" that could be produced by continuing strain 19 vaccination. In succeeding years, the "problems" were emphasized more and more by state and federal officials, and by parts of the cattle industry, without adequate regard for the situation in higher prevalence areas and their need for use of vaccine as used in California, North Dakota, and Wisconsin to aid in achieving lower prevalence of the disease. The concerns expressed about the "problems" of vaccination were at least as influential in decision making for cattle owners in some areas as the question of who was to pay for the vaccination.

Another factor in recommending reduction of vaccination was the tendency on the part of some state and federal regulatory officials to want to reduce program costs for "false positive" serologic tests, as the prevalence decreased in the dairy states such as New York, or in beef exporting states such as North Dakota. However, states such as California which import many dairy and beef cattle had the opposite view and continued to do their utmost to encourage vaccination and purchase of vaccinated cattle.

(b) Vaccination percentages can be misleading because vaccination of 30% of calves in a state does not indicate that 30% of calves in each herd are vaccinated, but rather that herd owners who vaccinated tend to vaccinate as high as 90-100% of their calves and other herd owners may vaccinate none of their calves.

(c) Recommendations on the age-range for vaccination may have reinforced a pattern of reduced vaccination since the restricted age for vaccination was inconvenient or not compatible with husbandry and management practices of many beef cattle owners.

4. States, classified as "Certified Free", have achieved this status using vaccination as an adjunct to herd management and disease prevention measures but the percent of calves vaccinated has varied greatly and the "Certified Free" status of a state was not solely dependent on having a 45% or greater calf vaccination. On the other hand, all states which have achieved 45% or greater vaccination also achieved brucellosis "Certified Free" status. Thus, achieving 45% or greater vaccination was positively associated with "Certified Free" status although these states and those "Certified Free" states without a high vaccination rate used a combination of other preventive measures to achieve "Certified Free" status.

F. Data on Efficacy of Strain 19 *Brucella abortus* Vaccine

Some cattlemen and government officials have been concerned that vaccination with Strain 19 vaccine may give only 65% protection and this has appeared to influence decisions about vaccination. In reality this figure seems to be a partial quote from Manthei[10] who summarized results of U.S.D.A. controlled experiments with Strain 19 and stated, "A compilation of all data from research at the National Animal Disease Laboratory indicates that 65 to 75% of the vaccinated animals will be *completely* protected against most kinds of exposure to virulent *Br. abortus*." But what most individuals fail to note is that the experiments also showed clear evidence that the virulence and dose of brucellae to which a cow is exposed, and the stage of pregnancy are important among the factors that influenced the protection rates of the vaccine. For example, in one experiment with an exposure dose of 350,000 brucellae instilled into the eye, complete protection resulted with no infection and no abortion. When the challenge dose was increased to 100,000,000 brucellae in another experiment, there was 71% infection of the vaccinates and 73% of the infected animals aborted. In another experiment using controlled natural exposure, only 20% of the vaccinates were infected but 100% of the infected vaccinates aborted their calves.

Results published by other investigators support the premise that protection is affected by the size of the dose of brucellae, stage of pregnancy and virulence of the organism.[10-20,22-24] Stuart[7] and Wixom,[21] evaluating 11 years of actual field use of vaccine in California, reported reductions in dairy cattle infection rates from 18% to 2% and reductions in beef cattle infection rates from 9% to 1% by 1959 and the beginning of the eradication program in California. Safford[23] reporting on vaccination in Montana provided data indicating that beef herds with 100% vaccination had only 0.21% infected animals compared to 1.06% infected animals for herds with no vaccination, i.e. vaccine gave five times the protection of no vaccination in field studies in Montana. In 1977, Vanderwagen *et al.*[47] reported: (a) herds disclosing only vaccinated reactors had an infection level of .69% and were quarantined an average of 6.39 months while (b) herds disclosing one or more nonvaccinated reactors had an eight-fold increase in reactors to 5.95% and

double the quarantine to 11.48 months. Furthermore those herds with nonvaccinated reactors were adversely influenced much more by management and calving practices not conducive to disease control.

Data were presented recently on studies of adult vaccination using reduced doses of Strain 19 vaccine. Although some of these studies were not complete at the time of presentation, the results were promising in the majority of data presented. Most data show that adult vaccination and removal of infected animal in a herd can reduce the number of new infection substantially, but these procedures alone are not sufficient to eliminate all infection, and they must be accompanied by epidemiologically sound practices of sanitation and management. Some investigations have not collected enough data to evaluate protection at this time. One author reported no difference in infection rates between adult vaccinates and adult non-vaccinates in a large dairy herd.

All of the studies found that post-vaccinal residual titers decreased in direct relation to the reduction in dose of Strain 19 organisms. Results of these studies, when completed, will assist in selecting an appropriate dose of vaccine to minimize post-vaccinal titers and obtain useful protection.[50-54]

It should be emphasized again that in actual field use, Strain 19 has been an aid in reducing infection within herds of cattle to low prevalence rates but has not by itself eliminated the infection in the majority of herds.[7,10-19,21,23,24,37,47]

Another factor influencing the use of Strain 19 vaccine is the problem of persisting postvaccinal serologic reactions which may interfere with detection of cattle infected with field strain *Br. abortus*.[14,18-22,25,33-39] To reduce the problem of persisting serologic reactions with present dosages and routes of administration of Strain 19 vaccine, officials recommend vaccination of calves at three to six months of age. Unfortunately this restricted age of vaccination is often incovenient or incompatible with husbandry and management practices of many beef cattle operations. These cattlemen often find it necessary to vaccinate calves at older ages and risk increased post-vaccinal serologic reactions, or to refrain from vaccinating their calves and not have the relative protection afforded by Strain 19 vaccine. The same difficulties occur in the more recently developing specialized dairy replacement business described in Section 4.3.

Dairy herd owners in the northern dairy states vaccinate fewer calves than in previous years because (a) it is not pushed or is even discouraged by their state and federal officials because of the perceived serological "problems", (b) it is no longer subsidized, (c) there is not a continuing feeling of threat or hazard of reinfection. This reduces the supply of vaccinated dairy heifers which could be used as replacements for the big dairies in the South, the West and Puerto Rico which do not want to raise their own heifers.

This discussion of vaccination and these data provide further examples and evidence of the importance of advice, knowledge and understanding of brucellosis and factors affecting the risk of infection of a herd, the economic factors, the type of cattle business and the motivation of cattle owners when one considers decisions to vaccinate or not vaccinate. Cattlemen are concerned about their own particular needs and these needs differ widely depending upon the type of cattle operation and the exposure potential for infection of these cattle.

Recommendations need to consider the wide variation in these needs among states, within states and among different herds; (1) as prevalence of brucellosis and exposure potential affect risk of infection; (2) as surveillance procedures and serologic tests are affected by vaccination; (3) as husbandry practices and patterns of movement of cattle affect risk of infection in individual herds; (4) as research on vaccination, vaccines and diagnostic procedures provide new data.

III. Brucellosis Reactor Rates for Herds and Cattle

A. Brucellosis Reactor Rates for Cattle 1946-76

Table 1.2.6 provides interesting historical and current data relating to animals tested on the farm, reactors detected, and the reactor rate per 1000 tested by three-year intervals for the 31 years 1946-1976. These data show that some of the presently "Certified Free" states formerly had very high rates in 1946, 1949 and 1952 which were similar to the rates currently observed in states which are designated as "Modified Certified" brucellosis areas. It appears that some states reduced infection rates while in other states, still modified certified, the rates remained at high levels with little reduction.

Table 1.2.6A provides data for the reactor rates of cattle tested at auction markets or at time of slaughter - MCI rate. The MCI reactor rates for these 12 states have decreased markedly from 1964-65 to the years 1975-76, with 1975-76 rates down at least 50% and as much as 90% less than 1965.

Table 1.2.7 presents data for the national MCI rates using all states in the U.S. These rates are used by U.S.D.A. as indicators of the prevalence of brucellosis reactors and herds of origin not previously detected. However, there are some problems of double counting and detection of persistent postvaccinal serologic reactions. It does provide, however, the best current estimate of new, or not previously known brucellosis reactors in each state and the U.S. It is of interest that the MCI reactor rate declined from a 1967 figure of .95 to a low of .43 in 1971, then increased to .71 in 1975 followed by a decrease to .53 in 1977. These data appear to reflect, in a relative manner, the increases and decreases in reactors that were occurring in the population, in spite of problems with the system and the possible confounding

Table 1.2.6

BRUCELLOSIS REACTOR RATE PER 1000 CATTLE TESTED FOR ON-FARM TESTS, THREE YEAR INTERVALS AND TOTALS (1946-1976)

	Reactor Rates											
Year	ALA **	CAL	FLA **	GA **	LA **	MN	MO **	NY	NC	ND	TX **	WI
1946	31	71	25	28	50	43	53	89	14	31	42	49
1949	39		91	46	111	45	73	69	73	43	64	48
1952	32		20	46	119	25	74	34	6	22	47	103
1955	33	18	20	27	87	19	34	18	4	20	38	48
1958	17	15	12	12	44	9	16	22	3	17	57	13
1961	17	12	36	11	31	4	10	11	2	8	15	5
1964	27	6	17	11	37	4	6	7	2	9	21	3
1967	25	6	19	22	43	4	10	1	2	1	16	1
1970	30	4	23	19	36	3	12	0.3	1	11	27	1
1973	43	7	14	24	41	4	11	2	2	5	40	1
1976	60	5	23	33	50	1	38	1	1	2	35	1
	Totals 1962-1976											
Total Tested	8,766,595	4,321,571	11,821,558	8,778,330	9,302,095	26,393,674	13,102,157	10,102,366	7,603,019	7,155,662	20,144,994	20,978,407
Total Reactors	259,490	39,571	266,222	195,135	423,533	562,563	325,833	412,244	60,857	162,808	587,741	862,481
Rate/1000 Tested	30	9	23	22	46	21	25	40	8	23	29	41

** Modified Certified States

Others = Certified Free States

TABLE 1.2.6A

RANK ORDER OF STATES BY BRUCELLOSIS REACTOR RATES PER 1000 CATTLE TESTED FOR MCI TEST RESULTS EACH YEAR AND TOTALS (1962 - 1976)

	Reactor Rates Per Thousand Cattle Tested											
	LA**	FLA**	TX**	ALA**	MO**	GA**	MN	CAL	WI	ND	NY	NC
1962	48	43	67	19	18	12	7	11	70	10	62	4
1963	63	43	69	20	17	11	1	6	10	16	11	-
1964	58	54	33	27	-	8	2	8	6	8	0	1
1965	43	41	28	23	2	5	3	4	.7	4	6	-
1966	41	35	21	16	3	5	2	3	1	4	5	1
1967	29	34	27	11	4	5	1	1	-	3	2	-
1968	20	22	24	11	4	4	1	1	0	3	1	1
1969	16	12	22	12	4	4	1	1	-	1	0	-
1970	11	8	16	9	5	4	1	1	0	1	0.3	0.6
1971	14	9	13	8	4	3	1	1	0	1	0	-
1972	12	11	16	8	4	4	1	1	1	1	0.4	0.6
1973	13	11	20	9	5	6	1	1	2	1	2	-
1974	21	12	19	7	6	6	1	1	1	1	1	0.6
1975	21	17	16	10	7	7	2	1	1	1	.7	-
1976	22	19	18	10	5	4	2	2	.6	1	0.7	0.7
	Totals 1962-1976											
Total Tested	2,450,302	1,693,935	8,735,890	2,392,798	4,459,104	3,111,281	3,151,832	2,421,555	2,435,040	1,766,783	458,676	1,207,335
Total Reactors	61,477	27,340	187,296	27,022	25,940	17,057	4,502	4,244	2,603	4,201	360	1,221
Rate/1000 Tested	25	16	21	11	6	6	1	2	1	2	1	1

TABLE 1.2.7

Data From All States of U.S.

BRUCELLOSIS REACTORS AND REACTOR RATES PER 1000 CATTLE TESTED IN MARKET CATTLE IDENTIFICATION SYSTEM (MCI) 1967-1977

Year	MCI Total Tested in U.S.	Number of MCI Reactors in U.S.	MCI Reactor Rate Per 1,000 Tested in U.S.
1967	4,612,964	43,918	0.952
1968	4,779,652	38,086	0.797
1969	4,932,167	31,595	0.641
1970	4,900,526	25,620	0.523
1971	5,400,968	23,264	0.431
1972	7,266,150	33,344	0.459
1973	8,460,030	53,093	0.628
1974	8,989,563	62,586	0.696
1975	11,242,879	80,461	0.716
1976	14,628,284	96,469	0.660
1977	13,501,362	71,807	0.532
TOTAL	88,714,545	560,243	
	$\bar{x}$ = 8,064,958	$\bar{x}$ = 50,931	$\bar{x}$ = 0.630

influence of the cattle cycle[40] (see Section 4.2).

Tables 1.2.8, 1.2.8A and 1.2.8B present data for the 13 survey states concerning the number of herds which disclose brucellosis reactor cattle on one or more tests during the fiscal year; thus providing an index of the magnitude of the reservoir and sources of brucellosis infection for the year.

Table 1.2.8 shows the period prevalence rate, using herds disclosing reactors during the year as the numerator and using the five year Agriculture Census data on number of herds in a state as the denominator.[2,29,30-32] Note that these data differ from the period prevalence rates in Table 1.2.8B which use the same numerator (herds disclosing reactors during the year) but use a different denominator as furnished and used by APHIS in cooperation with each state to calculate official brucellosis infected herd rates.[1] Both denominators cannot be correct. Either the Agricultural Census data are inaccurate, as claimed by the states, and should be corrected or the denominators used by the states in cooperation with APHIS are inaccurate and should be corrected. This is another example of the need for better systems to collect and manage data on animal populations and disease control including data on herd size, density of herds, movements of animals, etc. An additional problem is the fact that the Commerce Department does not publish Agriculture Census Data until three to five years after collection and this delay makes the data of much less value.

Table 1.2.8A has some interesting data showing that: (1) five presently Certified Free states, North Dakota, Minnesota, New York, Wisconsin and California, had more known reactor herds in 1961 than Florida and Georgia had in 1961; (2) California and Minnesota, from 1960 through 1967, had more known brucellosis reactor herds than Florida or Georgia; (3) Minnesota reduced reactor herds 98% from 746 in 1962 to 10 in 1976, and California reduced reactor herds 84%, from 532 in 1962 to 82 in 1976; (4) Georgia reported 592 reactor herds in 1962 and 511 reactor herds in 1976, only a 14% reduction. Florida reported 337 reactor herds in 1962 and 405 reactor herds in 1976, a 20% increase in known reactor herds between 1962 and 1976; (5) Alabama and Louisiana have maintained a relatively stable number of quarantined herds without any significant reduction from 1960 to 1976; (6) In Texas the number of reported reactor herds increased from about 2,000 in 1960 to more than 7,000 in 1971 and slightly less than 6,000 in 1976, an increase of greater than 300% from 1960 to 1971 and very little reduction between 1971 and 1976; (7) North Dakota decreased the number of reactor herds 97%, from 467 in 1960 to three reactor herds in 1976.

It is apparent that most of the Certified Free states had large reductions in quarantined herds while most of the presently Modified Certified states have increased or not significantly reduced the number of reactor herds reported in the past 15 years except for the state of

TABLE 1.2.8

TOTAL NO. OF HERDS WHICH HAD BRUCELLOSIS REACTORS FOUND BY TEST PER 1000 HERDS AT RISK DURING THE FISCAL YEAR (1960-1976)

Period Prevalence Rate for Total Reactor Herds for 13 Selected States

Year	ND	MN	WI	NC	NY	CAL	UT	MO **	GA **	ALA **	FLA **	TX **	LA **
1960	12.21	13.67	7.74	1.90	14.80	37.59	8.59	15.35	13.28	9.73	28.03	11.67	23.90
1961	12.55	8.19	6.36	1.60	7.13	31.22	5.09	12.98	5.76	12.77	18.99	11.98	21.20
1962	12.24	7.29	4.76	1.30	8.29	17.21	4.85	10.72	8.83	16.79	17.82	10.16	22.21
1963	8.13	7.52	3.77	0.84	5.31	10.68	4.85	7.95	6.31	16.84	15.13	17.02	19.00
1964	9.82	8.00	3.11	1.92	4.59	18.03	6.56	6.14	9.13	31.95	18.46	24.02	28.90
1965	7.95	7.34	1.45	1.57	3.83	16.00	2.56	5.91	8.96	29.66	20.91	12.17	29.20
1966	4.81	4.27	0.52	2.60	1.38	11.60	2.66	4.49	8.84	28.83	23.70	1.67	29.83
1967	3.11	2.22	0.29	3.38	1.11	7.00	3.07	5.82	9.36	21.39	61.78	20.80	77.41
1968	2.18	1.58	0.20	2.94	0.42	3.91	2.46	6.87	8.86	15.62	35.83	24.72	74.56
1969	1.52	1.47	0.13	2.96	1.03	1.72	3.78	4.34	10.62	16.00	32.26	48.74	101.80
1970	0.74	0.68	0.11	0.75	0.31	1.28	2.91	4.75	9.58	12.54	44.70	50.10	56.05
1971	0.47	0.62	0.11	0.64	0.24	1.66	2.32	3.83	7.60	11.93	60.20	52.55	28.87
1972	0.43	1.03	0.33	0.38	0.31	0.94	2.61	3.39	11.42	13.72	24.88	23.02	40.75
1973	0.16	0.55	0.27	0.70	0.51	1.16	1.89	3.02	13.49	18.15	26.37	24.29	40.75
1974	0.13	0.69	0.41	0.71	0.50	2.42	2.68	4.09	14.16	20.12	26.48	40.85	54.50
1975	0.08	0.35	0.39	0.46	0.69	3.21	5.44	5.05	16.37	23.19	23.40	50.73	62.42
1976	0.13	0.19	0.30	0.40	0.65	4.32	4.70	5.52	16.56	27.98	28.37	48.67	71.26

** Modified Certified States

Others = Certified Free States

Source: $\frac{\text{No. of Herds in which Reators were found by tests during the Fiscal Year (V.S. Form 4-35)}}{\text{No. of Herds in Each State Population, U.S. Agriculture Census 1974, Dept. of Commerce, Bureau of the Census}}$

Table 1.2.8A

TOTAL NO. OF HERDS WHICH HAD BRUCELLOSIS REACTORS FOUND BY TESTS DURING THE FISCAL YEAR FOR EACH OF 13 SELECTED STATES (1960-1976)

Year	TX**	LA**	ALA**	GA**	MO**	FLA**	CAL	UT	WI	NY	NC	MN	ND
1960	2041	1415	781	892	2046	530	1162	108	842	830	166	1399	467
1961	2096	1256	1025	387	1730	359	965	64	692	400	140	838	480
1962	1777	1316	1348	592	1429	337	532	61	518	465	113	746	468
1963	2977	1125	1352	424	1060	286	330	61	410	298	73	770	311
1964	3310	1267	1718	440	624	271	451	64	294	199	84	713	325
1965	1677	1280	1595	432	601	307	400	25	137	166	69	654	263
1966	1332	1308	1550	426	456	348	290	26	49	60	114	380	159
1967	2866	3394	1150	451	592	907	175	30	27	48	148	198	103
1968	3406	3269	840	427	698	526	98	24	19	18	129	141	72
1969	6788	2588	625	370	372	433	31	26	9	30	33	88	39
1970	6977	1425	490	334	407	600	23	20	8	9	36	41	19
1971	7319	734	466	265	318	808	30	16	8	7	22	37	12
1972	3206	1036	536	398	291	334	17	18	23	9	13	62	11
1973	3383	1036	709	470	259	354	21	13	19	15	24	33	4
1974	4953	1115	688	437	326	378	46	18	26	13	23	36	3
1975	6151	1277	793	505	403	334	61	37	25	18	15	18	2
1976	5902	1458	957	511	440	405	82	32	19	17	13	10	3
TOTAL	66161	26299	16623	7761	12062	7517	4714	643	3125	2602	1205	6164	2741

** Modified Certified States

Others = Certified Free States

Table 1.2.8B

NO. OF HERDS IN WHICH BRUCELLOSIS REACTORS WERE FOUND BY TESTS PER 1000 HERDS AT RISK DURING THE FISCAL YEAR (1972-1976)

Year	ND	MN	NC	WI	NY	CAL	UT	MO **	GA **	ALA **	FLA **	TX **	LA **
1972	.43	.96	.22	.28	.22	.63	2.1	2.6	8.1	9.9	18.5	19.6	28.0
1973	.15	.51	.42	.23	.37	.78	1.3	2.3	9.5	13.1	19.6	20.76	28.0
1974	.11	.55	.40	.32	.32	1.7	1.9	2.9	8.9	12.7	21.0	30.4	30.1
1975	.07	.27	.26	.31	.45	2.2	3.9	3.6	10.3	14.7	18.5	37.7	34.5
1976	.11	.15	.22	.23	.42	3.0	3.4	4.0	10.4	14.7	22.5	36.2	39.4

** Modified Certified States

Others = Certified Free States

Source: $\dfrac{\text{No. of herds in which Reactors were found by tests During the Fiscal Year (V.S. Form 4-35)}}{\text{No. of Herds in Each State Population.Personal Communication, Dr. Winthrop Ray,V.S., APHIS, and Cooperating State Veterinarians}}$

Missouri which has reduced reported reactor herds 78%, from 2,046 in 1960 to 440 in 1976. It should be noted that these data reflect differences in efforts to find reactor cattle in Texas between 1960 and 1976 for example, and thus the data do not reflect a real increase in infected animals but rather an increase in detection and reporting of reactors.

Examples from Table 1.2.8A Showing Progress of States in Reducing Number of Brucellosis Reactor Herds from 1960 to 1976

Name of State and Number of Reactor Herds

Year		MO	TX	MN	LA	CA	GA	ND	GA
1960	=	2046	2041	1399	1415	1162	892	467	530
1976	=	440	5902	10	1458	82	511	3	405

It is interesting to note the comparison on number of infected herds as summarized in the example above. Missouri and Texas had about 2,000 reactor herds in 1960 but, by 1976 in Missouri they had decreased to about 400, while in Texas there was an increase to about 6,000 reactor herds. Louisiana and Minnesota had about 1400 reactor herds in 1960. By 1976 Louisiana still had about 1400 while Minnesota had only 10 reactor herds. Florida and North Dakota had about 500 reactor herds in 1960. By 1976 Florida had about 400 reactor herds while North Dakota had only three reactor herds. California and Georgia both had reductions in reactor herds but California's decreased from 1162 to 82 while Georgia is decreased from 892 to 511. These data indicate that among states which had a similar number of reactor herds in 1960, some were able to greatly reduce the number of reactor herds by 1976.

Table 1.2.8A shows the total number of herds of cattle in which brucellosis reactors were disclosed during FY 1976. Texas has the most reactor herds but Louisiana (Table 1.2.8A) has relatively more disease with the most reactor herds per 1,000 herds at risk in the population. This Table 1.2.8A also shows that the "Certified Free" states had from three to 82 reactor herds disclosed during the year. These data lead to a question about the standards and criteria for brucellosis "Certified Free" status, since obviously none of these 12 states were absolutely free of reactor herds in 1976. Many individuals testified before the Commission that they believed "free" should mean "zero" brucellosis reactor herds during the year. Resolution of some of the questions could be accomplished if attempts were made to isolate *Brucella abortus* from every reactor herd in "Certified Free" states in order to differentiate between reactors infected with field strains of *B. abortus*, and those reacting because of residual strain 19 titers. Such a program is in effect in Montana and is highly cost-effective.

Tables 1.2.9 and 1.2.10 are thought provoking in terms of comparing states by proportion of cattle tested and reactor rates within the limitations of available data. For example, in Table 1.2.10 North Carolina and Minnesota are the highest of the states for cattle tested, with rates of 56 and 55 per 100 cow years, because these two states, for many years, conducted area tests in which every cow in every county of the state was tested at regular intervals. California has, for these 31 years, the lowest rate of 13 cows tested per 100 cow years. This is said to reflect the moratorium on testing from 1948 to 1957 and the reduced need for multiple testing as a result of vaccination and close surveillance of importation of cattle. California has not conducted change of ownership testing except as local circumstances would indicate a need for such testing in a limited area for a limited time e.g. presently in Riverside and San Bernadino Counties. Their decision to limit testing on change of ownership was based on the low prevalence of brucellosis within the state, and the protective effect of a high level of vaccination.[26] This decision saves considerable money, but if brucellosis increases further, general change of ownership testing may have to be instituted. Such a decision would increase costs and inconvenience for industry in the state. This is another example of how changes in prevalence influence the type of brucellosis program and how a small increase in prevalence in a low prevalence state with an effective program can influence their costs.

Table 1.2.9 lists the states in rank order by reactor rate. It is most interesting to compare Tables 1.2.9 and 1.2.10. It should be observed that California has the lowest rate of reactors per 1,000 cattle tested and also has tested the least cattle. It has been hypothesized that these two facts indicate that California's vaccination and testing program was more cost effective in terms of reducing reactors and saving indemnity and testing costs than were the programs of Minnesota and North Carolina. Minnesota and North Carolina, which did not encourage nor mandate vaccination and had less than 25% vaccination of female calves, are below the median for percent reactors, but this may be an artifact of the large denominators created by testing all cattle on area tests for many years.

Wisconsin and North Dakota, which continued high levels of vaccination with an effective program for removal of infected cows, have an intermediate level of cattle that were tested from 1954 to 1976. This could be attributed to both vaccination effect and the prevention of further transmission by prompt and effective removal of reactors.

Texas has a very low rate of testing which is attributed to use of only a single area test for Modified Certification, its rather late achievement of Modified Certified status, and the reliance on the MCI system. Texas also has a moderate rather than higher rate of reactors during this 31 year period which has been attributed to the low prevalence rates found west of Highway I-35, which counterbalance the higher

TABLE 1.2.9

TOTAL ACCUMULATED NUMBER OF BRUCELLOSIS REACTORS COMBINING MCI TEST RESULTS 1962-76 AND ON-FARM TEST RESULTS 1946-76 IN 12 STATES LISTED IN RANK ORDER BY REACTOR RATES PER 1,000 CATTLE TESTED

Selected State	Total Cow Years	Total Number of Reactor Cattle	Rate of Reactors/ 1000 Cattle Tested
Louisiana **	32,306,008	485,010	41
New York	40,937,148	412,604	39
Wisconsin	74,553,224	865,084	37
Texas **	164,954,716	775,037	27
Alabama **	29,995,808	286,512	26
Florida **	32,243,000	293,562	22
Missouri **	64,164,208	351,773	20
Minnesota	53,404,964	567,065	19
No. Dakota	31,818,784	167,009	19
Georgia **	25,403,728	212,192	18
No. Carolina	15,773,996	62,068	7
California	51,965,640	43,815	6
TOTAL	617,521,224	4,521,741	25
			($\bar{x}$ = 23.4)

** Modified Certified States

Others = Certified Free States

TABLE 1.2.10

TOTAL ACCUMULATED NUMBER OF CATTLE TESTED FOR BRUCELLOSIS IN 12 STATES
LISTED IN RANK ORDER BY RATE OF CATTLE TESTED PER 100 COW YEARS
FOR EACH STATE POPULATION OF COWS 1962-76

Selected State	Total Cow Years	Total Number of Cattle Tested	Rate of Cattle Tested/100 Cow Years
North Carolina	15,773,996	8,810,354	56
Minnesota	53,404,964	29,545,506	55
Georgia **	25,403,728	11,889,611	47
Florida **	32,243,000	13,515,493	42
Alabama **	29,995,808	11,159,393	37
Louisiana **	32,306,008	11,752,397	36
Wisconsin	74,553,224	23,413,447	31
No. Dakota	31,818,784	8,922,445	28
Missouri **	64,164,208	17,561,261	27
New York	40,937,148	10,561,060	26
Texas **	164,954,716	28,880,834	18
California	51,965,640	6,743,126	13
TOTAL	617,521,224	182,754,927	

** Modified Certified States

Others = Certified Free States

Table 1.2.11

COMPARISON OF HERDS WITH REACTORS AS A PERCENT OF MCI HERDS TESTED
RESULTS OF INITIAL ON-FARM BLOOD TESTS
(1967-1972-1977 Ave.)

Rank Order	Ave. No. of MCI Reactor Herds of Origin Tested	Ave. No. of Herds with Reactors	Rank Order Herds with Reactors: Percent of Herds Tested
Louisiana **	1229.2	666.0	54.2%
Florida **	257.6	119.4	46.4
Alabama **	757.4	330.3	43.6
Georgia **	406.3	160.8	39.6
Texas **	2676.6	937.4	35.0
North Dakota	78.8	18.6	23.7
Missouri **	549.7	121.9	22.2
California	82.8	16.9	20.4
New York	16.8	2.0	11.9
North Carolina	101.1	6.8	6.7
Minnesota	121.9	5.9	4.8
Wisconsin	73.5	2.1	2.9%

** Modified Certified States

Others = Certified Free States

Table 1.2.11A

RESULTS OF INITIAL ON-FARM BLOOD TESTS OF HERDS OF ORIGIN
OF BRUCELLOSIS REACTORS DETECTED BY MCI PROGRAM
(1967-1972-1977 Average)

	Rank Order Mean Herd Size of Reactor Herds	Average Number of Reactor Animals in the Reactor Herd	Average of the Percent of Reactor Animals in the Reactor Herds
New York	288	3	1%
California	214	7	3%
Florida **	79	8	10%
North Carolina	66	6	9%
Texas **	55	6	11%
North Dakota	55	7	13%
Louisiana **	49	6	12%
Wisconsin	44	8	13%
Missouri **	42	7	16%
Alabama **	42	7	16%
Georgia **	37	6	15%
Minnesota	35	6	18%

** Modified Certified States

Others = Certified Free States

prevalence rates among the cattle found in counties generally lying the area east of Highway I-35.

B. Brucellosis MCI Herds of Origin and Reactor Rates

Table 1.2.11 compares the 12 states in terms of percent of MCI herds of origin which, when tested, have additional reactors in the herd. These data show that in higher prevalence states such as Texas, Louisiana, Florida, Alabama, and Georgia 35% to 54% of MCI herds of origin tested have additional reactors for an efficiency of 35% to 54% in detecting reactor herds. New York, North Carolina, Minnesota and Wisconsin have an efficiency of 2.9 to 11.9% in testing herds of origin to find additional reactors. Obviously the question of screening tests for MCI tracebacks needs further evaluation and research. These data also show that what is needed in the higher prevalence states for screening may not be appropriate for low prevalence states, again indicating the need for expert epidemiologic judgement and flexibility within and among states.

Table 1.2.11A shows the average number of reactor cattle and percent of reactors in the reactor herds in each state, ranked by size of reactor herds, detected by tests for the Market Cattle Identification System. New York and California have the largest herd size of reactor herds for MCI tests, almost three times larger than the Florida and North Carolina herds, which have an average reactor herd size of 79 and 66 cattle, respectively. Reactor herds in Texas have an average of 55 cows, the same herd size as North Dakota. Louisiana and Wisconsin reactor herds average 49 and 44 cows, respectively, while Georgia and Minnesota reactor herds are the smallest with an average of 37 and 35 cows, respectively. From these data, it appears that in lower prevalence states, the size of herds with brucellosis reactors is about the same or larger than the average size of reactor herds in the higher prevalence states. For example, reactor herds in North Carolina are larger on the average than reactor herds in Texas, and reactor herds in Texas and North Dakota have the same average size. It is also worth noting that even though the percent of reactor animals in these herds goes up as the herd size decreases, the actual number of reactors varies only from six to eight animals (except New York = 3) for 11 of the 12 states regardless of herd sizes, which range from 216 to 35 animals. The median number of reactors is 6. Percent reactors ranges from 1% for the large New York herds to 18% for the smaller Minnesota herds. There appears to be little difference in number of reactors among reactor herds, whether they are in low prevalence states or higher prevalence states, or whether they are located in the East or West, North or South. Infection within reactor herds appears to be very similar at the time of initial herd test, regardless of region or state status, thus raising questions about adequacy of surveillance procedures for early detection. Further data to analyze MCI results according to size of herd of origin, type of cattle operation, movement of cattle, etc.

should be collected in relation to MCI reactor herds of origin to provide a basis for improvement.

C. Brucellosis Milk Ring Test Results

Table 1.2.12 compares herds with reactors as a percent of herds with suspicious milk ring test results. Results of initial on-farm blood tests of herds, undertaken because of milk ring test reactions, show that in five of the higher prevalence states, the percent of MRT suspicious herds with blood test reactors ranges from 71% for Florida to 36% for Georgia. Wisconsin and North Carolina have 8 and 9% of MRT suspicious herds with reactors while 30% of the California MRT suspicious herds have reactors. Florida with 71% reactor herds among the MRT suspicious herds may be less effective in early detection of herds with only a few reactors, since they have an average of five reactors (2.7%) on initial blood test as shown in Table 1.2.12A. In contrast, California where the average reactor herds are larger, has only four reactors per reactor herd.

There is also probably much slower spread in the recently infected California herds because of high vaccination levels, the 30-60 day retesting of purchased replacements and closer supervision of program components. Table 1.2.12A column 2 data, on number of reactors, ranges from one to five per herd among the 12 states and the median is three reactors per herd. These data substantiate previous observations that the milk ring test is a better surveillance procedure than the MCI. MCI herds, when detected, disclose an average of six reactors on initial test compared with three reactors for MRT suspicious dairy herds which are also larger than the average MCI reactor herd. Thus, in this analysis of surveillance, the milk ring test (MRT) is at least twice as sensitive as the MCI testing system in early detection of herds which have blood test reactors.[19,22,33-38,45]

Table and figure 1.2.13 present an excellent picture of the dramatic decline of brucellosis infected dairy herds and associated milk ring test (MRT) suspicious reactions of dairy herds in the 12 states. It is of interest to note that in 1952 New York had a MRT suspicious herd rate of 620 herds/1000 tested. This was very similar to the rates of 607/1000 in Georgia and 775/1000 in Louisiana, during the first years of using the milk ring test to detect herds suspicious for brucellosis infection. These rates have been reduced in "Certified Free" New York to the current rate of 1/1000 herds, in Georgia to 4/1000 herds, and in Louisiana to 21/1000 herds.

The early and continuing decrease in brucellosis infected dairy herds as indicated in Table and Figure 1.2.13 appears to have been significantly influenced by (1) the use of an excellent surveillance test ---- the Milk Ring Test[42-46,48] and (2) by Grade A milk laws and regulations which required milk ring test suspicious dairy herds to

Table 1.2.12

COMPARISON OF HERDS WITH REACTORS AS A PERCENT OF BRT HERDS TESTED. RESULTS OF INITIAL ON-FARM BLOOD TESTS (1967-1972-1977 Ave.)

Rank Order	Ave. No. of BRT Suspicious Herds Tested	Ave. No. of Herds with Reactors	Rank Order Herds with Reactors As Percent of Herds Tested
Florida **	188.0	134.0	71.3%
Texas **	280.8	139.0	49.5%
Alabama **	51.6	22.5	43.6%
Louisiana **	121.5	48.3	39.8%
Georgia **	48.5	17.4	35.9%
California	78.1	24	30.7%
North Dakota	19.4	5.4	27.8%
Minnesota	105.1	20.6	19.6%
Missouri **	265.5	43.4	16.3%
New York	40.6	6.5	16.0%
Wisconsin	103.8	9.9	9.5%
North Carolina	53.5	4.3	8.0%

** Modified Certified States

Others = Certified Free States

Table 1.2.12A

RESULTS OF INITIAL ON-FARM BLOOD TESTS OF HERDS ORIGINALLY DETECTED BY THE MILK RING TEST FOR BRUCELLOSIS
(1967-1972-1977 Average)

	Rank Order Mean Herd Size of Reactor Herds	Average Number of Reactor Animals in the Reactor Herd	Average of the Percent of Reactor Animals in the Reactor Herds
California	220	4	1.7%
Florida **	187	5	2.7%
Texas **	97	4	4.3%
Georgia **	84	3	2.8%
Louisiana **	83	3	3.3%
Alabama **	82	4	4.8%
New York	50	3	5.7%
North Carolina	48	1	3.0%
Wisconsin	35	2	5.9%
Missouri **	33	2	6.7%
North Dakota	30	4	13.5%
Minnesota	29	3	10.9%

** Modified Certified States

Others = Certified Free States

TABLE 1.2.13

NO. OF DAIRY HERDS PER THOUSAND HERDS TESTED THAT WERE DETECTED AS SUSPICIOUS FOR BRUCELLOSIS BY THE MILK RING TEST. COMPARISON AND RANK ORDER OF HERD SUSPICIOUS RATES PER 1000 HERD MILK SAMPLES TESTED FROM 12 SELECTED STATES (1952-1976)

Herd Rate Per 1000 Herds Tested

	WI	NY	MN	ND	MO **	GA **	CAL	NC	TX **	LA**	FLA **	ALA **
1952	353	620	199	182		607	313				209	
1953	336	563	181	26		574				775	151	
1954	310	410	174	26	459	429				798	195	
1955	204	452	157	24	646		461			701	200	
1956	104	226	60	30	171	388	414	20		572	301	380
1957	50	174	42	17	126	275	433	8	598	504	568	184
1958	29	114	32	19	112	241	267	12	521	457	517	187
1959	17	57	23	15	62	159	228	10	358	307	484	165
1960	12	20	14	17	25	93	143	6	318	155	437	90
1961	7	10	14	9	19	68	116	4	197	104	294	95
1962	3	5	4	9	12	47	66	4	105	72	244	52
1963	2	4	3	5	9	35	45	3	78	53	179	34
1964	1	2	2	3	8	18	45	3	41	38	145	23
1965	.9	2	3	6	9	17	25	9	36	45	199	32
1966	.8	1	2	4	10	11	27	4	35	38	165	21
1967	.9	1	1	3	26	16	16	4	25	28	152	16
1968	.6	1	1	3	8	16	10	3	21	20	133	27
1969	.3	1	1	3	6	14	4	5	27	39	186	23
1970	.2	1	1	1	6	21	4	4	33	63	222	19
1971	.2	1	1	1	2	12	2	2	30	21	161	12
1972	.3	1	1	1	2	17	1	6	21	28	150	11
1973	.4	1	1	1	2	6	1	4	19	24	64	13
1974	1	1	1	1	2	6	5	4	24	23	46	15
1975	.8	1	1	1	1	2	4	6	33	24	49	17
1976	.5	1	1	1	1	4	5	7	15	21	21	24

*Rate = No. of Herds Suspicious/1000 Herds Tested ** Modified Certified States Others = Certified Free States

blood test for brucellosis and immediately remove any reactors. Many people believe the most important factor in the decrease was the penalty of losing Grade A milk status if a herd was not complying with brucellosis regulations. Grade B herds were exempt from the Grade A milk laws but the pressure from Grade A dairymen for protection of their herds from outside infection caused many states to require that dairy cattle herds producing Grade B milk also comply with brucellosis regulations to detect and eliminate infection from their herds. Thus, the dairy herd owner had positive and negative economic incentives to eliminate brucellosis and maintain a brucellosis free herd through management and purchase policies, where state and local health departments were requiring full compliance with milk laws and regulations.

Changes in these milk ring test suspicious rates have also been influenced by the decrease in the number of small dairy herds and the concentration of dairy cows in larger herds. This change has helped in some states to reduce disease, but in others such as Florida, the increase in size of herds and the associated husbandry and purchase practices, and lack of a coherent vaccination policy, have helped to maintain brucellosis infection in the larger dairy herds. California, as reported by Vanderwagen,[47] has been able to reduce infection in the very large dairy herds by requiring a high level of vaccination, mandatory retest of purchased replacements, and by appropriate use of management and husbandry procedures to reduce spread of brucellosis within these large dairy herds. Herds with 100% vaccination had fewer brucellosis infected cows than herds with one or more nonvaccinated reactor cows. These data support the use of 100% vaccination, and improved husbandry practices to reduce and further prevent brucellosis in large dairy herds which are continually at risk of exposure through import of about 33% of cows each year as herd replacements. Some herds avoid the continual exposure from adding cattle of unknown origin to their herds either by raising their own replacement calves and heifers, or obtaining them from dependable brucellosis-free sources.

It should be noted that two Certified Free states, California and North Carolina, had higher rates of Milk Ring Test suspicious herds than two Modified Certified states, Missouri and Georgia in 1976. This again raises questions about present methods of classifying areas as "Certified Free".

D. Comparison of Traceback and Testing Procedures for Herds of Origin of MCI Reactors Detected at First Point of Concentration

Table and Figure 1.2.14 present data on the outcomes of tracing reactors, tested on change of ownership, or at first point of concentration, in relation to testing conducted for the herd of origin of the reactor identified through market cattle testing. First, it should be noted that three of the "Certified Free" states, do not have "first point of concentration" or change of ownership testing, and testing is limited to imported animals from other higher prevalence

Figure 1.2.13

NO. OF DAIRY HERDS SUSPICIOUS FOR BRUCELLOSIS AS DETECTED BY THE MILK TING TEST FOR EACH 1,000 HERDS TESTED *. COMPARISON OF RATES/1,000 FROM SELECTED STATES (1952-1976).

* Rate = No. of herds suspicious/1000 herds tested.

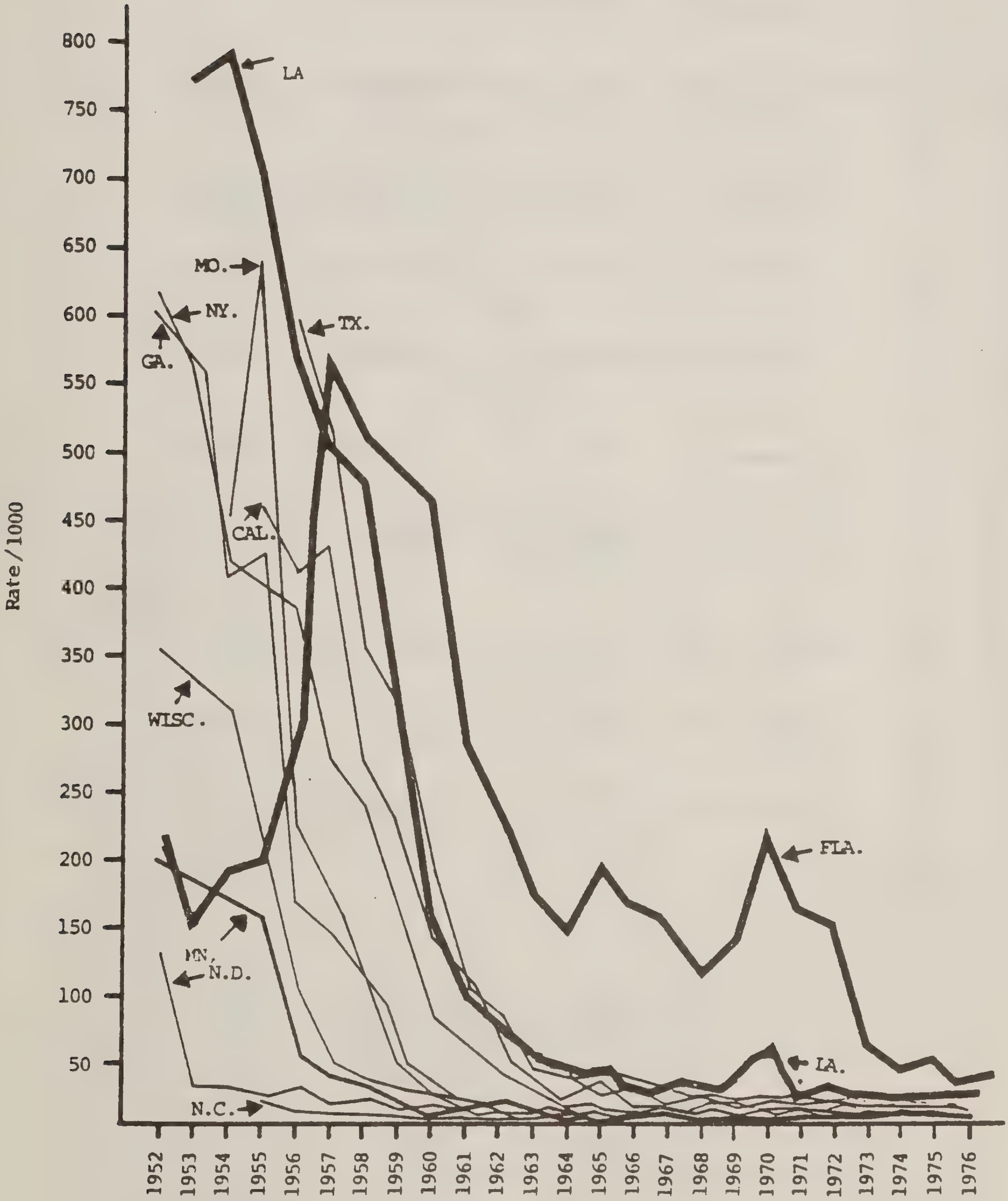


Table 1.2.14

COMPARISON OF TESTING PROCEDURES FOR HERDS OF ORIGIN OF BRUCELLOSIS REACTORS DETECTED BY TESTING CATTLE SOLD AT FIRST POINT OF CONCENTRATION FOR YEAR 1976 FOR SELECTED STATES IN THE U.S.

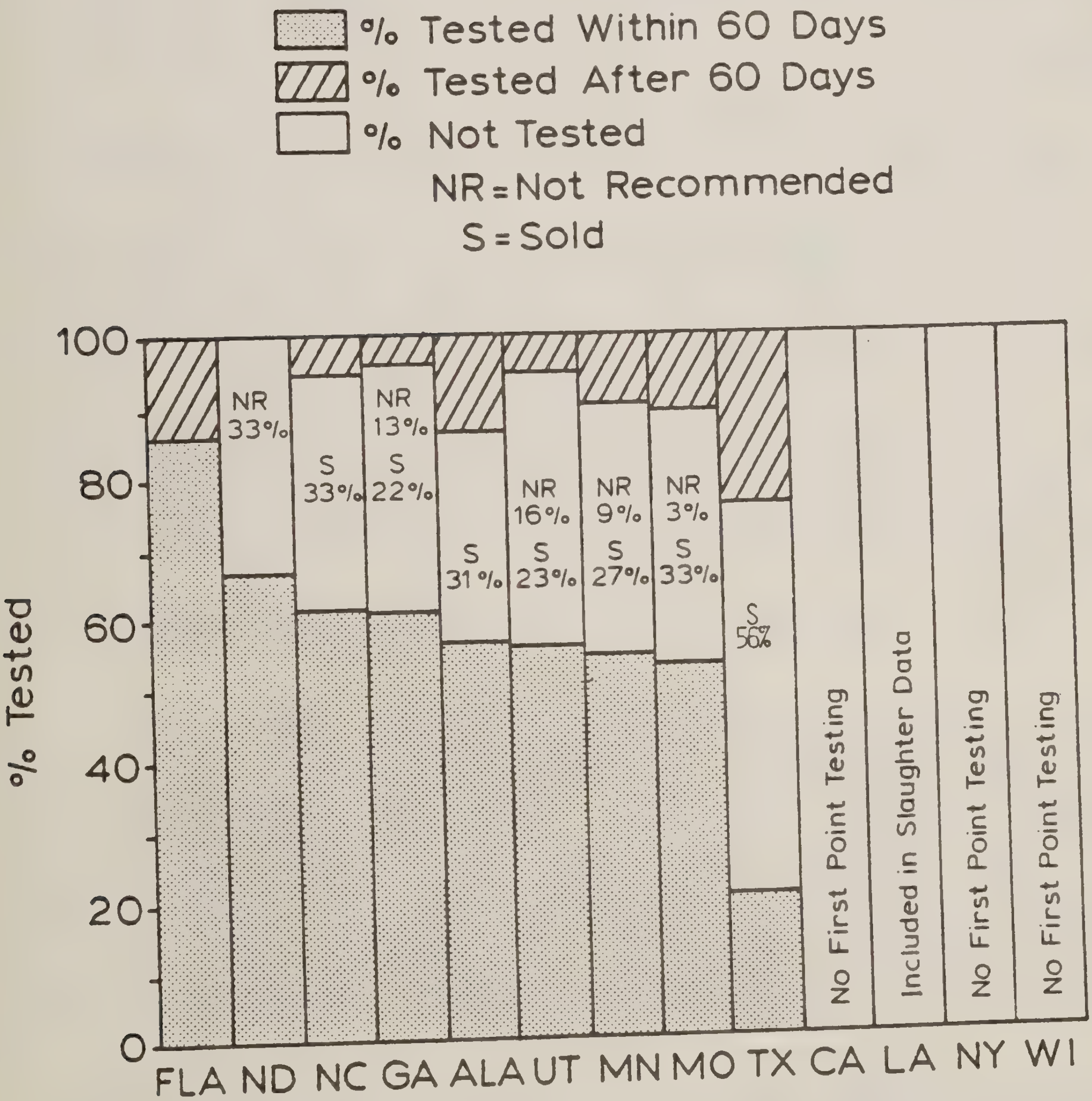
Percent of Herds not Tested or Tested in Each Time Category and Totals for Each State

Traceback of Market Reactors: Outcome of Herd of Origin	% Florida**	% No. Dakota	% No. Carolina	% Georgia**	% Alabama**	% Utah	% Minnesota	% Missouri**	% Texas**	% California	% New York	% Wisconsin	% Louisiana**
1. Not Tested Because										No First Point Testing	No First Point Testing	No First Point Testing	Not Available
a. All Animals Sold	NONE	0	33%	22%	31%	23%	27%	33%	56%				
b. Not Recommended	NONE	33%	0	13%	--	16%	9%	3%	----				
Subtotal	NONE	33%	33%	35%	31%	39%	36%	36%	56%				
2. Initial Herd Test Conducted within "X" Days After Lab Test													
a. Within 1-30 days	60%	0	38%	53%	35%	54%	46%	32%	6%				
b. Within 31-60 days	26%	67%	24%	8%	21%	2%	9%	21%	14%				
c. Within 61-90 days	7%	0	0	2%	8%	2%	0	6%	14%				
d. More than 90 days	8%	0	5%	2%	6%	2%	9%	5%	9%				
Subtotal	100%	67%	67%	65%	69%	61%	64%	64%	44%				
Total Herds Traced	#117	#3	#21	#701	#1053	#43	#11	#412	#3834				
%Tested more than 60 days	14%	0	5%	4%	14%	4%	9%	11%	23%				
%Not Tested	NONE	33%	33%	35%	31%	39%	36%	36%	56%				
%Tested within 60 days	86%	67%	62%	61%	56%	56%	54%	53%	20%				

*Additional cattle from quarantined herds at markets included to qualify for indemnity and reactors traced to quarantined feedlots and untraceable reactors.

** Modified Certified States   Others = Certified Free States

Figure 1. 2.14 Traceback of Reactors at Market: % Tested Within X Days



states. This may be appropriate in theory, but import surveillance is often not able to prevent introduction of infection from higher prevalence areas, and then change of ownership testing may be needed to provide earlier detection of new infection imported into the state. This problem of importing infected cattle raises costs for "Certified Free" areas and has led to the new restrictions on imports from Canada,[49] as well as a requirement, in at least 22 states, for retesting imported breeding animals 30-90 days following importation depending upon their origin.

Table 1.2.14 shows under item 1 the percent of tracebacks to herds of origin which were not tested as reported by each state. Item 2 presents the time period between the test at the market and the initial test of the herd of origin. Ideally, the test of the herd of origin should be within 30 days; testing the herd of origin within 60 days is considered acceptable; however a time period greater than 60 days is not satisfactory in terms of good epidemiologic follow-up.

Florida reported testing 100% of the traceback herds and testing 86% within a 60 day period.

Texas reported testing only 44% of the traceback herds because 56% of the traceback owners indicated that all animals in the pasture (herd) had been sold, and were not available for testing; 20% were tested within 60 days following detecting a reactor animal at the market test. Thus, only 20% of the herds were reported to have a satisfactory test of the first point of concentration surveillance. The other six states reported data, between Florida and Texas, showing from 31% to 39% of herds of origin not tested, and showing from 53% to 67% of the herds of origin being tested within a satisfactory 60 day period. From 0% to 14% were tested after more than 60 days which is considered unsatisfactory. Figure 1.2.14 presents these data graphically.

E. Comparison of Traceback and Testing Procedures for Herds of Origin of MCI Reactors Detected at Slaughter

Table and Figure 1.2.15 present data for traceback of reactors detected at slaughter plants, and the reported data differ considerably from those in Table 1.2.14 dealing with first point of concentration testing. For example, seven states reported less than 50% of herds of origin of slaughter plant reactors were tested within 60 days, ranging from 5% for Texas to 49% for Utah. Four "Certified Free" states had the best test records; New York tested 98% of herds of origin within 60 days, and the other three states ranged from 58% to 84%. In the category "testing this herd not recommended", California had 70% of tracebacks, "not recommended for testing"; North Dakota had 69%; Georgia had 74%; Texas reported none (0%) and New York 2%.

In questioning officials of California and North Dakota about the high rate of, "testing this herd not recommended", they pointed out that when these slaughter reactors were traced to the herd of origin, it was

determined by a state or federal veterinarian that herd status and history indicated that many of the slaughter reactions were related to over-age vaccination, or testing young animals at slaughter. These reactors were judged to be serologic reaction caused by Strain 19 vaccine. The necessary follow-up investigations to determine herd status, were a disadvantage of high rates of vaccination as practiced in California and North Dakota. Wisconsin with a moderate rate of vaccination had 35% of traceback herds "not recommended for testing" following investigation of the herd of origin. These data indicate again the need for further research on vaccines and methods of vaccination to avoid or differentiate post-vaccinal reactions from reactions due to field infection. The record also indicates that California, Wisconsin and other states with high vaccination rateshave developed personnel capable of judging and interpreting these situations.

Table 1.2.15 and Figure 1.2.15A show that, "herd sold out", is another category used to explain why herds of origin of MCI reactors are "not tested". Use of this category represents a failure to test the herd of origin and failure of MCI. Obviously if all animals in the herd have actually been sold, there may be no exposed or potentially exposed animals to test. However, upon questioning cattle owners and field personnel, it was soon determined that the term "sold out" is often applied to only one of several pastures or premises, where one owner maintains cattle, with the potential of transfer of infection along with normal movement of personnel, equipment and cattle between pastures. The concept of <u>not</u> testing cattle owned by one individual or firm because they are in different pastures or premises is <u>not</u> usually epidemiologically sound, because one owner usually operates several pastures or premises to best advantage by intermixing personnel and equipment and moving individual cows or groups of cattle among pastures in accord with good husbandry and management practices and economic conditions. Thus cattle in more than one of the pastures have a probability of having been exposed if an MCI reactor originates from one of these pastures.

Table 1.2.15 and Figure 1.2.15A show that six states failed to test from 10% to 48% of MCI herds of origin because "all animals were sold" from a particular pasture or premise, but not necessarily all animals in an operating group of cattle or premises with owner. Figure 1.2.15A shows that North Carolina had 13% "sold out", Minnesota 11% and Utah 16% among the "Certified Free" states. Among the "Modified Certified" states, Texas had 48% failures to test, reported as "sold out", Alabama 41% and Florida had 28% reported as "sold out". These herds of origin reported as sold out represent a failure of the MCI system to provide effective surveillance of potential sources of brucellosis infection in the community where a reactor originated. This problem area needs to be improved if the surveillance is to be improved.

The data appear to be consistent with previous observations: (1) that herd tests are conducted earlier following detection of reactors at

Table 1.2.15

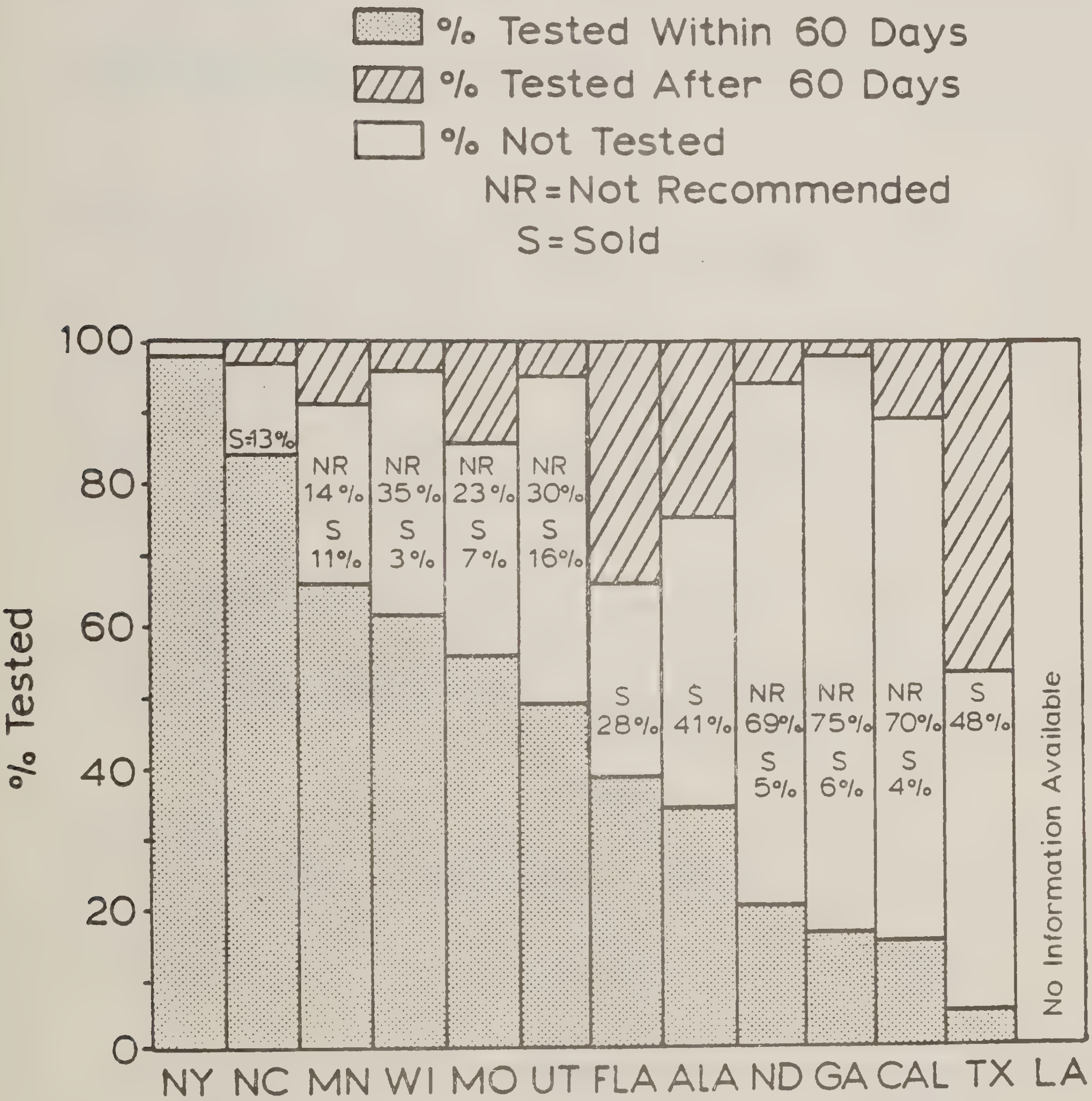
COMPARISON OF TESTING PROCEDURES FOR HERDS OF ORIGIN OF BRUCELLOSIS REACTORS DETECTED BY TESTING CATTLE AT TIME OF SLAUGHTER FOR YEAR 1976 FOR 13 SELECTED STATES

Traceback of Reactors at Slaughter Outcome for Herd of Origin	New York	No. Carolina	Minnesota	Wisconsin	Missouri**	Utah	Florida**	Alabama**	No. Dakota	Georgia**	California	Texas**	Louisiana**
	%	%	%	%	%	%	%	%	%	%	%	%	%
1. Not Tested Because													
a. All Animals Sold	NONE	13%	11%	3%	7%	16%	28%	41%	5%	6%	4%	48%	
b. Not Recommended	2%	0	14%	35%	23%	30%	NONE	NONE	69%	74%	70%	0	
Subtotal	2%	13%	25%	38%	30%	46%	28%	41%	74%	80%	74%	48%	
2. Initial Herd Test Conducted Within X Days After Lab Test													
a. Within 1-30 days	0	63%	54%	31%	30%	33%	8%	11%	10%	15%	5%	0	
b. Within 31-60 days	98%	21%	12%	27%	26%	16%	30%	23%	10%	2%	10%	5%	
c. Within 61-90 days	0	0	3%	3%	9%	5%	15%	15%	2%	3%	6%	36%	Not Available
d. More than 90 days	0	3%	5%	1%	6%	0	19%	10%	5%	1%	5%	10%	
Subtotal	98%	87%	74%	62%	71%	54%	72%	59%	27%	20%	26%	51%	
Total Herds Traced	#119	#62	#221	#218	#431	#37	#1119	#440	#157	#137	#693	#9730	
%Tested more than 60 days	0	3%	8%	4%	15%	5%	34%	25%	7%	4%	11%	46%	
%Not Tested	2%	13%	25%	38%	30%	46%	28%	41%	74%	80%	74%	48%	
%Tested within 60 days	98%	84%	66%	58%	56%	49%	38%	34%	20%	16%	15%	5%	

** Modified Certified States

Others = Certified Free States

Figure 1.2.15A Traceback of Reactors at Slaughter: % Tested Within X Days



first point of concentration than when detected at the slaughter plant; (2) that the MCI system and traceback is a useful system when properly conducted to effectively detect brucellosis reactor animals not previously detected for traceback to the herd of origin; (3) that improvements in the system and the traceback testing are needed to increase effectiveness; (4) that the ability of the system to detect infected herds depends on the amount of movement of animals, their identification, and the phase of the cattle cycle which influences the amount of culling of animals from breeding herds. It appears that the efficacy of the system also depends on the problems of each state and the differences between states in the interpretation and follow up of results; the man-power and effort devoted; and the initial efforts to provide identification.

In looking at traceback effectiveness it becomes clear that identification of cattle is of paramount importance, not only for the brucellosis program but for others such as tuberculosis, cattle scabies, etc. Therefore, it seems that developing and implementing a system and appropriate hardware to permanently identify each head of cattle in the U.S. at or before first change of ownership should be a primary goal of industry and health officials.

F. Comparison of Serologic Tests and Laboratory Procedures Conducted by Laboratories in 13 States

1. Comparison of Blood Serum Tests and Other Procedures

Table 1.2.16 presents data for serologic tests and laboratory procedures. Texas and Wisconsin collected the largest numbers of samples among the 13 selected states. Five states provided data regarding unsatisfactory samples of blood serum received at the laboratories for testing. (see example below)

Example

Number of Blood Samples Received by the Laboratory as Not Satisfactory for Serologic Testing (hemolized, spoiled, insufficient quantity, etc.)

Name of State	# of Samples Not Satisfactory for Lab Test	% of Total Samples Not Satisfactory
Florida	3,000	00.3%
Wisconsin	6,000	00.4%
Alabama	40,000	7.0%
Texas	419,000	18.0%
Louisiana	109,000	24.0%

These data clearly indicate a serious problem for cattle owners in

TABLE 1.2.16

COMPARISON OF SEROLOGIC TESTS AND LABORATORY PROCEDURES CONDUCTED BY LABORATORIES IN 13 STATES

Number and Type of Serologic Tests and Laboratory Procedures	ND Thous. Tests	MN Thous. Tests	WI Thous. Tests	NC Thous. Tests	UT Thous. Tests	NY Thous. Tests	CAL Thous. Tests	MO** Thous. Tests	GA** Thous. Tests	ALA** Thous. Tests	TX** Thous. Tests	LA** Thous. Tests	FLA** Thous. Tests
1. # of Blood Samples Collected at Farm	10	100	160	28	60	96	280	258	231	204	263	286	999
2. # of Blood Samples Collected at Markets and Slaughter	159	784	1221	30	88	205	547	468	632	376	2096	160	49
3. Total Samples Collected Farm & MCI Origin	170	889	1381	58	148	301	827	724	863	580	2359	446	1048
4. # of Samples Received Not Satisfactory for Testing	--	--	6	--	--	--	--	--	--	40	419	109	3
5. % of Samples Received as First Test Samples	85%	60%	99%	48%	99%	100%	100%	35%	70%	10%	71%	20%	70%
6. # of Standard Tube Tests	--	19	19	--	--	77	No	--	--	2	28	No	0
7. # of Standard Plate Tests	170	228	65	30	--	No	827	--	--	2	14	--	0
8. # of Rapid Screening Tests	No	657	No	No	--	205	No	No	No	--	1939	--	0
9. # of Acidified BBA Plate Tests	No	16	No	--	--	No	No	—	--	580	No	--	--
10. # of Card Tests	1.3	62	--	--	--	--	9	726	--	50	119	--	--
11. # of 2-ME Tests	No	15	No	No	--	No	No	No	No	.3	28	No	--
12. # of Rivanol Tests	1	1	1	--	--	No	--	--	--	6	60	--	No
13. # of Complement Fixation	No	No	7	No	No	No	No	No	--	--	No	No	No
14. Are Known Serums Used Daily as Control Samples													
a. Known Positive Serums Each Day	No	Yes	No	No	Yes	Yes	No	Yes	No	No	No	No	No
b. Known Negative Serums Each Day	No	Yes	No	No	Yes	Yes	No	Yes	No	No	No	No	No
c. Check Test Samples Each Day	No	No	No	Yes	No	No	No	No	No	No	No	No	No
15. Would Lab Be Interested in Having Control Serums Available	Yes	Yes	Yes	--	Yes	No	--	Yes	Yes	--	Yes	Yes	Yes

Alabama, Texas, and Louisiana, and perhaps other states not reporting when or how many blood samples are not satisfactory for testing when received at the state-federal laboratory for the official serologic test. These reported data show that 1/4 of blood samples collected in Louisiana and 1/5 of blood samples collected in Texas do not receive an official test. This means that all the time, effort and money that was spent in identifying animals, collected the blood samples, transporting the samples, receiving the samples and unpacking them, only to find them unsatisfactory, was wasted. This also means that if the cattle owner needed the results of an official test, there would be a delay as well as duplicate efforts and costs in collecting fresh blood samples to again send samples to the lab. Everyone involved has a responsibility to set up a system and make it work to assure satisfactory samples.

Only Alabama and Minnesota reported using the acidified BBA plate test[33] and antigen in place of using the Card Test[33] as appropriate to save funds. Only three of the 13 states reported using the micro-titer rapid screening test (RST)[33] which was developed for use as a screening test for MCI program samples.

Only Wisconsin, among the 13 states, reported using the Complement Fixation test (CF),[38] although it is in use in Florida in adult vaccinated herds, in South Carolina, and Oklahoma and on a referral basis for samples submitted from other states.

This clearly indicates a need for laboratories to develop the capability to conduct the CF test as well as the Rivanol test which are very useful to epidemiologists and well-trained field personnel for interpreting serologic titers that may appear to be related to strain 19 vaccination. The principal laboratory for each state or for a group of states should have the capability to accurately conduct: (1) Regular tests and screening tests, (2) the CF test and the Rivanol test as supplemental tests, (3) viability and total cell counts of strain 19 vaccine, (4) the appropriate bacteriologic procedures to culture and isolate *B. abortus*, *B. suis* and *B. melitensis* from milk and at least 10 other tissues, including placentae from cows, from fetuses and calves as indicated.[19,20,22,33,34,41]

Data in this study indicated that very few labs are checking the viability and total cell counts of Strain 19 vaccine being used in the field. Viability counts will be even more important if experiments, now in progress, lead to adoption of vaccine with a reduced number of *B. abortus* Strain 19 viable organisms. Review of Table 1.2.16 emphasizes the differences between and among states in their laboratory tests and procedures. Items 14 and 15 further indicate the need for more appropriate quality control systems to improve accuracy in many of the 13 labs. It is considered favorable that nearly all labs would welcome assistance in providing control serums for daily reference and self examination.

TABLE 1.2.17

COMPARISON OF MILK OR CREAM TESTS AND LABORATORY PROCEDURES
CONDUCTED BY STATE-FEDERAL LABORATORIES IN 13 STATES

Number and Types of Serologic Tests and Laboratory Procedures	No. Dakota	Minnesota	Wisconsin	No. Carolina	Utah	New York	California	Missouri**	Georgia**	Alabama**	Texas**	Louisiana**	Florida**
Milk Samples													
# of Herd Samples	7000	106,000	147,000	8,600	5,713	57,327	12,400	19,300	8,000	2,227	9,792	4,529	2,500
# of Fresh Milk	--	40,000	100,000	0	200	NA	11,100	--	8,000	2,227	0	0	0
# of Preserved Milk	7000	66,000	47,000	8,600	5,513	NA	1,300	--	0	0	9,792	4,529	2,500
Are Samples Monitored for Condition?	NO	YES	NO	YES	NO	YES	YES	YES	--	NA	YES	YES	YES
Milk Ring Test													
Herd Size for Use of 1 ml Test	125	125	0-150	150	YES	1-200	1-200	100	YES	YES	150	YES	126
Herd Size for Use of 2 ml Test	NO	125+	150+	450	YES	201-500	201-500	150+	100+	100+	--	150-350	126-350
Herd Size for Use of 3 ml Test	NO	NO	--	451-700	NO	501-900	501-900	450+	--	NO	--	351-500	351-650
Herd Size for Use of Segmentation	NO	NO	--	NO	YES	901+	901+	NO	--	--	--	NO	650+
# of Samples for Serial Dilution MRT	50	25	179	--	250	NA	--	--	500	50	50	--	--
Are Known Milk Control Samples Used Each Day?													
a. Known Positive Milk	NO	NO	NO	NO	YES	YES	NO	YES	YES	NO	NO	NO	NO
b. Known Negative Milk	NO	NO	NO	NO	YES	YES	NO	YES	YES	NO	YES	NO	NO
Does Lab. Use Negative Cream in MRT?													
a. Cream Obtained by Gravity Separation	NO	YES	YES	YES	YES	--	NO	YES	--	--	YES	YES	--
b. Cream Obtained by Mechanical Separator	YES	NO	NO	NO	NO	--	YES	NO	--	--	NO	NO	--
# of Cows Cultured for B. Abortus	0	38	124	20	110	56	--	32	165	10	149	23	--
# of Cows B. Abortus Isolated	--	4	3	6	64	10	52	8	14	2	65	0	--
# of Isolates Sent to VSL	--	4	2	6	50	10	52	6	14	2	0	0	--

-- indicates information not available   ** Modified Certified States   Others = Certified Free States

2. Comparison of Milk Ring Test and Other Procedures

Table 1.2.17 provides data on the number of milk samples collected by those 13 states and other procedures. Some states use preserved milk samples, some use both fresh and preserved samples, but many labs and officials in the program are not fully aware of the problems and differences in handling each type of sample. In addition the procedures for conducting the milk ring test on milk from herds with more than 100 lactating cows vary greatly, particularly with regard to the use of 2 ml and 3 ml of milk in the testing procedure. It is not, that all labs must use exactly the same procedure, but rather that the procedure used is scientifically appropriate to maximize detection of herds with infected animals, and minimize detection of herds with no infected animals. From the reported data, it appears that there is an urgent need for greater emphasis on laboratory support and coördination with the field personnel to further the goal stated above.

Table 1.2.17 indicates that most of the state-federal labs are attempting bacteriologic culture of B. abortus from some cattle but the results appear variable. It appears that much more attention should be given to assisting those laboratories and increasing cooperation and coordination with the epidemiologists to improve the value and efficacy of the bacteriologic culturing program for meeting the needs of the states and regions for diagnostic assistance.

Large amounts of money are devoted to indemnity payments or to identifying animals and collecting blood and milk samples, but only a small fraction of the total appropriation is devoted to assuring the quality of the laboratory tests and procedures which aid the field veterinarian and epidemiologist in making a diagnosis of brucellosis in a herd. Unfortunately not enough attention, in comparison to other aspects, has been given to the development and maintenance of quality laboratory programs which work in close cooperation with well-trained epidemiologists and field personnel. As indicated by Tables 1.2.16 and 1.2.17 many laboratories need assistance with special training of personnel, adequate equipment, facilities and supervision to achieve and maintain quality, including special, but necessary, laboratory skills and coordination with the field.

IV. A. Brucellosis Program Data and Procedures

This Table 1.2.18 attempts to summarize a number of program procedures which play a critical role in allowing or preventing the spread of brucellosis.

Much of the data favor reduction of prevalence of infection such as:

1. All states report they have adopted "S" branding to identify "negative exposed cattle".

2. All 13 states report they follow "Uniform Methods and Rules" in quarantine and retesting of negative exposed cattle and

3. 10 of the 13 states report an attempt to protect against introducing infection by requiring retest of imported cattle at 30-90 days following importation, to search for previously negative but exposed animals.

On the other hand, certain practices hinder the reduction of prevalence of infection such as:

1. only one of the 13 states limits the importation of known brucellosis reactors for slaughter. These reactors provide an additional exposure hazard for animals and people and at least 2 states have taken action to reduce this exposure.

2. only one of the 13 states requires reactors to go directly to slaughter to avoid the possibility of exposing negative healthy cattle at an auction market or when using several trucks.

3. only six of the 13 states reported investigating and testing at least one contact or neighborhood herd for each newly infected herd. Some states with relatively higher rates of infection where contact and neighborhood test could be very effective, reported testing a very small proportion of contact or neighborhood herds for each newly infected herd. Missouri was a notable exception where such testing is encouraged.

4. that the reported number of complete epidemiological investigations of newly infected herds was lower than expected and indicates a need for much greater emphasis on epidemiologic investigations in certain states.

From these simple data in Table 1.2.18 it is apparent that many persons including cattlemen, veterinarians and livestock inspectors are not fully aware of, or concerned about, the hazards of transmission of brucellosis to other herds. It is also recognized that lack of funds and personnel may limit activities of neighborhood testing and epidemiologic follow-up but these activities must have a higher priority. If one is to consider a goal of brucellosis control toward local eradication, greater understanding and more motivation for "need to know" must be generated. It seems that people forget or do not understand that brucellosis is a contagious and infectious disease that is a hazard to animals and people.

B. Licensing Authority and Compliance Actions

1. Table 1.2.19 presents data reported by the 13 states which indicates that seven of the 13 states have some authority to regulate cattle dealers by law, however these answers are misleading because the

TABLE 1.2.18

SUMMARY OF BRUCELLOSIS PROGRAM PROCEDURES REGARDING TESTING OF EXPOSED CATTLE AND DETECTION OF ADDITIONAL EPIDEMIOLOGICALLY RELATED HERDS WITH BRUCELLOSIS REACTORS IN 1976

Brucellosis Program Data and Procedures	ALA**	CAL	FLA**	GA**	LA**	MN	MO**	NY	NC	ND	UT	TX**	WI
1. Date of Adoption of "S" Branding of "Negative Exposed" Cattle	1975	--	1977	1974	1972	1975	1975	1976	1975	1975	1976	1976	1977
2. Procedure Followed for Quarantine and Retesting of Exposed Cattle	UMR	UMR	UMR	UMR	UMR	UMR	UMR	UMR	UMR	UMR	UMR	UMR	UMR
3. Is Retesting of Imported Cattle at 30 - 60 Days Required?	YES	YES	NO	YES	NO	YES	YES	YES	YES	YES	YES	NO	YES
a. Who Pays for Test?	--	Owner	--	State-Fed.	--	Owner	Owner	--	State-Fed.	Owner	Owner	--	Owner
4. Is Slaughter of Reactors Prohibited Except Reactors From Your State and Neighbor States	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES
5. Are Reactors Required to Go Directly to a Slaughter Plant Without Being Unloaded or Moved Through a Market?	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO
6. Number of Newly Infected Herds Reported in 1976	697	56	237	365	1172	5	333	15	12	3	3	5902	17
7. Number of Contact Herds Tested in 1976	72	31	0	0	168	12	600	20	35	16	70	0	8
8. Number of Neighborhood Herds Tested in 1976	--	0	0	0	--	0	15	1	28	0	--	0	2
9. Percent of Reactor Herds Found by Testing Neighborhood and Contact Herds	82%	0	0	0	54%	0	10%	0	10%	12.5%	0%	0	0%
10. Number of Complete Epidemiological Investigations of Newly Infected Herds in 1976	697	19	--	--	398	2	220	18	10	3	--	--	11
11. Number of Abortions Investigated in 1976	8400	1	--	225	--	119	40	366	20	0	--	1165	1551
12. Number of Abortions that were Due to Brucellosis	--	1	--	91	345	0	0	3	0	0	--	57	0

-- indicates information is not available ** Modified Certified States Others = Certified Free States

TABLE 1.2.19

SUMMARY OF BRUCELLOSIS PROGRAM PROCEDURES RELATING TO CATTLE DEALER RECORDS AND CATTLE IDENTIFICATION AND ACTIONS REGARDING COMPLIANCE

Cattle Dealer Records and Cattle Identification	ALA **	CAL	FLA **	GA **	LA **	MN	MO **	NY	NC	ND	UT	TX **	WI
1. Does State Have Authority to Regulate Cattle Dealers in Reference to Records and Identification of Cattle By Law?	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes	No	No	No	Yes
2. Does State Have Authority to Regulate Cattle Dealers in Reference to Records and Identification of Cattle Regulation?	Yes	No	No	No	Yes	Yes	No	No	No	No	No	No	--
3. Does State Law or Regulation Provide for a License?	Yes	No	No	Yes	--	Yes	No	Yes	Yes	--	Yes	No	Yes
4. Does State Law or Regulation Provide for a Registration or Permit?	--	No	No	No	Yes	--	No	Yes	--	--	Yes	No	--
5. Does State Law or Regulation Provide for a Bond?	Yes	No	No	Yes	Yes	Yes	No	Yes	No	No	Yes	No	No
6. Does State Law or Regulation Provide for Administrative Hearings?	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	--	Yes	No	Yes
7. Can Hearing Officer Suspend the Dealers License?	Yes	No	No	Yes	Yes	Yes	No	Yes	Yes	--	Yes	No	Yes
8. May a Judge Impose a Fine for Violations?	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	--	Yes	No	Yes
Actions Regarding Compliance													
1. How Many Investigations were Initiated in 1975-76?	21	3	1	--	16	2	3	1	11	27	2	--	150
2. Number of Administrative Hearings that were Held?	4	0	--	--	0	0	0	0	0	0	1	--	4
3. Number of Suspensions or Revocations of Professional License or Permit?	0	0	--	--	0	0	0	0	0	0	1	--	5
4. Number of Court Cases Before a Judge or Jury	14	3	1	--	2	2	3	0	0	8	2	--	6
5. Number of Court Cases Resulting in Convictions?	12	3	3	--	0	2	1	0	0	7	--	--	6
6. Number of Court Cases Resulting in Suspension or Revocation of License?	0	0	--	--	0	0	0	0	0	0	--	--	0
7. Number of Fines by Judge?	12	3	APP	--	2	2	1	0	0	7	--	--	6
8. Average Fine in Dollars	$150.	$688.	APP	--	0	$175.	$8.33	0	0	$87.14	--	--	$188.

--- indicates information not available ** Modified Certified States Others = Certified Free States

authority may be vested in different departments in different states and require varying amounts and quality of records or information for traceback of cattle to herd of origin.

Three states have authority under regulations to require identification and records. Seven states require a license and one additional state requires a permit. Six states require a bond and 8 states, of the 13, have authority to suspend the dealers license or permit.

2. Table 1.2.19 also presents data regarding compliance actions toward any individual or firm violating laws and regulations pertaining to brucellosis. It is clear that the appropriate data were not available in some states. In others, very little was initiated or accomplished in terms of the questions asked and the data reported. However, these data tend to confirm information given to the Commission in public hearings and interviews that it was simpler and easier to get around or ignore laws and regulations on brucellosis rather than to comply with them, because; (1) there was seldom any penalty; (2) district or county attorneys and federal attorneys were reluctant to become involved in such cases and most often prosecutions were not recommended; (3) if a prosecution was successful, the fine levied by the judge would be so small that it was no real penalty and just considered a cost of doing business.

The state reporting the most fines - seven - by a judge was North Dakota, a Certified Free state and the average fine was $87.00. California reported three fines by a judge for brucellosis violations and the average fine was $688.00 more than three times as much as reported by any of the other seven states reporting one or more fines.

From these data and statements made to the Commission it appears that enforcement of laws and regulations for brucellosis does not have much influence on the program, and certainly not a positive influence. Other incentives and rewards, both positive and negative, must be devised to motivate people and provide accountability for the person spreading brucellosis infection, if there is to be a control program leading toward local eradication in one or more states.

In addition it is apparent that the states in this study had 13 different approaches to enforcement of laws and regulations as well as having different laws and regulations.

V. A. Comparison of State Funded Manpower Resources for All Animal Health Activities

Table 1.2.20 presents data, not just for brucellosis activities in a state, but rather to look at the overall funding and infrastructure of manpower resources for all animal health and disease control programs in the 12 selected states. It was hypothesized that states which had strong veterinary medical manpower resources were

TABLE 1.2.20

COMPARISON OF STATE FUNDED MANPOWER RESOURCES-FIELD PERSONNEL-ALLOCATED TO ALL ANIMAL DISEASE CONTROL ACTIVITIES ACCORDING TO NUMBER OF CATTLE AND AMOUNT OF INCOME FROM CATTLE IN EACH OF 12 STATES*

State	Rank Order of Ave. No. of Man-Years of DVM'S (Field Personnel Only) Per 1,000,000 Cattle	Ave. No. of Man-Years of Non-DVM'S (Field Personnel Only) Per 1,000,000 Cattle	State	Rank Order of Ave. No. of Man-Years DVM'S (Field Personnel Only) Per $1,000,000 Income*	Ave. No. of Man-Years of Non-DVM'S (Field Personnel Only) Per $1,000,000 Income*
New York	9.5	3.7	New York	5.1	2.0
California	8.0	3.4	North Carolina	3.2	14.8
North Carolina	7.3	33.6	Florida**	2.8	19.0
Louisiana**	4.7	18.0	Louisiana**	2.3	9.0
Florida**	4.5	30.0	California	1.8	.80
Wisconsin	2.7	3.3	Alabama**	1.5	7.1
Alabama**	2.1	9.7	Georgia**	1.0	34.4
Minnesota	1.8	1.4	Wisconsin	.55	.70
Georgia**	1.3	43.5	Minnesota	.54	.40
Missouri**	0.6	1.6	Missouri**	.40	1.0
Texas**	0.5	13.7	Texas**	.31	8.3
North Dakota	0.4	.63	North Dakota	.23	.35

* Comparison based on data for year 1976 only

** Modified Certified States   Others = Certified Free States

expressing a commitment to help protect the state's livestock industry not only against brucellosis, but expressing a commitment to all animal disease control and prevention programs which would also be reflected in the status of the brucellosis program of the state.

The data in the left hand columns for field DVM's per/1,000,000 cattle in the population tends to confirm this hypothesis to the extent that the top three states in manpower resources are Certified Free states; and four of the top six states in manpower resources are Certified Free. Of the four states with the least manpower, only one of the four was a Certified Free state in 1976. Florida and Louisiana rank 4th and 5th in DVM manpower but are among the Modified Certified states with relatively high rates of brucellosis reactors. Thus manpower per million cattle is of itself not sufficient to control and eradicate brucellosis and the data suggest that program effectiveness depends on how the manpower resources are used, other program needs and other factors in each state. For example this rate only considers the cattle population and does not consider other species such as poultry, turkeys, swine, sheep, horses, or other programs such as tick and screwworm control.

In suggesting that it was not just the amount of manpower but rather how it was used one might use the following example: North Dakota ranks near the bottom with Texas in both tabulations of manpower, but North Dakota is Certified Free while Texas is a Modified Certified state with a relatively much higher brucellosis infection rate. In fact, one may question how Texas, with only eight field DVM's and 0.5 DVM's per 1,000,000 cattle, can handle the more than 4,000 brucellosis reactor herds which were known in 1976, in addition to all other animal health activities. North Dakota's success has been achieved, in part, through programs that involve the practicing veterinarian in official disease control programs of the state. In the past, accredited veterinarians also provided essential assistance in the brucellosis programs of such states as California, Wisconsin, Minnesota, New York, etc. during the period when the infection rate was being reduced. But as these states became "Certified Free" the work of these veterinarians was reduced. Practitioners served as an extension of the State Veterinarian's office. They were also helpful in educating and motivating the livestock owner in North Dakota. In addition, it should be noted that both Texas and North Dakota use manpower funded by the federal government and this federal-funded manpower is not counted in Table 1.2.20 which evaluates only state funds and is often used as a proxy for motivation.

It is concluded that states with strong professional manpower resources are generally associated with Certified Free status but it also depends on how these manpower resources are being used, the relative importance of other animal species and the priority of other programs in each of these states.

B. Use of Manpower for the Brucellosis Program

Table 1.2.21 presents data on the use of DVM, Non-DVM and Epidemiologists in the brucellosis programs of 12 states. As one reviews the data it becomes apparent:

1. that private practicing veterinarians have very little or no involvement in present brucellosis programs in these states. That might be expected in Certified Free states but it seems important for Texas, Louisiana, Alabama and other Modified Certified states to involve practicing veterinarians as North Dakota, California and other states did in past years.

2. that most of the states are not appropriately using veterinary epidemiologists to conduct or supervise herd investigations or to consult with and develop a plan for the owner. This may be because they do not have enough trained epidemiologists available, if so more specialized training for epidemiologists is needed to provide competent assistance for the livestock owner.

3a. that when veterinarians conduct the epidemiologic investigation and attempt to help the owner develop a plan, there must be some quality control mechanism and some accountability on the part of the state-federal employee or practitioner to the livestock owner. This means the DVM must have expert knowledge to properly advise the owner. Too often at present the owner is not receiving appropriate advice or help to plan his program because of a need for regular up-dating the knowledge of the DVM regarding brucellosis. This again emphasizes the need of special education for all individuals (DVM or Non-DVM) who are doing this work. Some advice that has been given is incorrect and inappropriate, while others have given contradictory advice. Knowledge and understanding are required of all, and training programs must be a high priority for all who advise the livestock owners.

3b. this also means that owners who have herds with infected cattle or herds that become infected, must also have knowledge to assist in developing an appropriate plan for his own herd and to know how and why to follow the plan. California's law requires an owner to cooperatively plan for eliminating the disease from his herd, and then to follow the plan or pay all costs and penalties of having the state eliminate the disease from his herd.[26] Thus, owners must also be provided with new knowledge and be responsible for appropriate application to eliminate brucellosis from their herds.

C. Comparison of Federal Manpower Devoted to Brucellosis Programs

Table and Figure 1.2.21 present a profile of the time, in man-years, devoted to brucellosis program activities by Federal employees from 1962 to 1976. The table and figure clearly show a large reduction of federal man-years devoted to the brucellosis program. The number of

Table 1.2.21

MANPOWER UTILIZATION FOR INVESTIGATION OF BRUCELLOSIS REACTOR HERDS
PERCENT OF HERDS HANDLED BY EACH TYPE OF SPECIALIST

	ALABAMA**				CALIFORNIA				FLORIDA**				GEORGIA**			
	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.
Handles RX Herds	1%	49%	50%	0%	0%	100%	0%	0%	0%	some	majority	0%	0%	25%	75%	0%
Brands RX Herd	1	49	50	0	0	0	75	0	0	some	majority	0	0	10	90	0
Explains Disease to Owner	1	75	25	0	0	0	0	100	0	some	some	some	0	50	50	25
Conducts Epid. Investiga.	1	65	35	0	0	0	0	100	0	100	0	0	0	50	50	25
Consults with Owner to Develop Plan	0	90	10	0	0	0	0	100	0	100	0	0	0	50	50	25

	LOUISIANA**				MINNESOTA				MISSOURI**				NEW YORK			
	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.
Handles RX Herds	1	0	99	0	0	100	0	0	10	40	50	0	0	100	0	0
Brands RX Herd	1	0	99	0	0	100	0	0	75	25	0	0	0	100	0	0
Explains Disease to Owner	1	98	0	1	0	100	0	0	10	45	45	0	0	100	0	0
Conducts Epid. Investiga.	1	98	0	1	0	100	0	0	0	50	50	0	0	100	0	0
Consults with Owner to Develop Plan	1	98	0	1	0	100	0	0	40	30	30	0	-	100	-	100

	NORTH CAROLINA				NORTH DAKOTA				TEXAS**				WISCONSIN			
	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.	Priv. Vet.	Gov't. Vet.	Livstk. Inspec.	Vet. Epid.
Handles RX Herd	0	100	0	0	0	25	75	0	5	5	89	1	0	100	100	0
Brands RX Herd	0	100	0	0	0	25	75	0	5	0	95	0	0	100	100	0
Explains Disease to Owner	0	100	0	0	0	25	75	0	5	5	89	1	0	100	0	100
Conducts Epid. Investiga.	0	100	0	0	0	25	75	0	0	10	90	0	0	100	0	100
Consults with Owner to Develop Plan	0%	100%	0%	0%	0%	25%	75%	0%	5%	5%	89%	1%	0%	100%	0%	100%

** Modified Certified States   Others = Certified Free States

man-years started to decrease from a high point in 1966 and continued to decrease until 1974 when only 37% of the man-years were being applied that were applied in the peak year of 1966. This 63% reduction in manpower was followed by an increase in the number of brucellosis cases in people and animals. As shown in the Table and Figure 1.2.22, other corollary programs impinged on the efforts of APHIS staff and took special time and attention away from brucellosis to handle newer programs and emergency programs such as the outbreaks of hog cholera, Venezuelan equine encephalitis and Newcastle disease which occurred from 1970 to 1974.

In 1975 and 1976 funding was increased to provide 692 man-years of federal employees for brucellosis program activities. These increases were encouraging and additions may be needed, but more importantly there is a need to look at the manner in which manpower is used to assure that (1) they have been appropriately trained for the program, (2) they make every effort to assist cattle owners in developing and carrying out plans to free their individual herds from brucellosis as part of the concept of control toward local eradication, (3) they receive adequate support and supervision from program leaders and supervisors, (4) data are collected and utilized to evaluate and adjust or redirect program activities in terms of accountability and achievement of program objectives.

At this time it appears that one of the most pressing needs in terms of manpower is to provide continuing education and special training for both federal and state employees and for practicing veterinarians so they can more efficiently and effectively assist cattle owners in preventing and eliminating the disease from their herds. Special training and greater involvement of private practicing veterinarians should be a <u>priority item</u> particularly in states with higher prevalence of brucellosis. Private practitioners were essential members of the team in on-farm testing, calfhood vaccination and in providing advice and consultation to cattle owners in past years, and they can again provide valuable assistance and consultation if they desire to participate.

Table 1.2.22

PROFILE OF TIME DEVOTED TO BRUCELLOSIS PROGRAM ACTIVITIES BY FEDERAL EMPLOYEES MEASURED AS FEDERAL MAN-YEARS

Fiscal Year	Number of Man-Years	Illustration of Other Programs Utilizing This Same Pool of Man-Power as Emergency or Corollary Programs			
1962	1443				
1963	1441				
1964	1441				
1965	1440				
1966	1469				
1967	1374				
1968	1404				
1969	1276	Animal Welfare			
1970	1183	Animal Welfare	Hog Cholera		
1971	748	Animal Welfare	Hog Cholera		
1972	700	Animal Welfare	Hog Cholera	Newcastle Disease	VEE
1973	575	Animal Welfare	Hog Cholera	Newcastle Disease	VEE
1974	540	Animal Welfare	Hog Cholera	Newcastle Disease	
1975	648	Animal Welfare			
1976	692	Animal Welfare			

Figure 1.2.23 Profile of Time Devoted to Brucellosis Program Activities by Federal Employees Measured as Federal Man Years

Illustration of Other Programs Utilizing This Same Pool of Manpower as Emergency or Corollary Programs

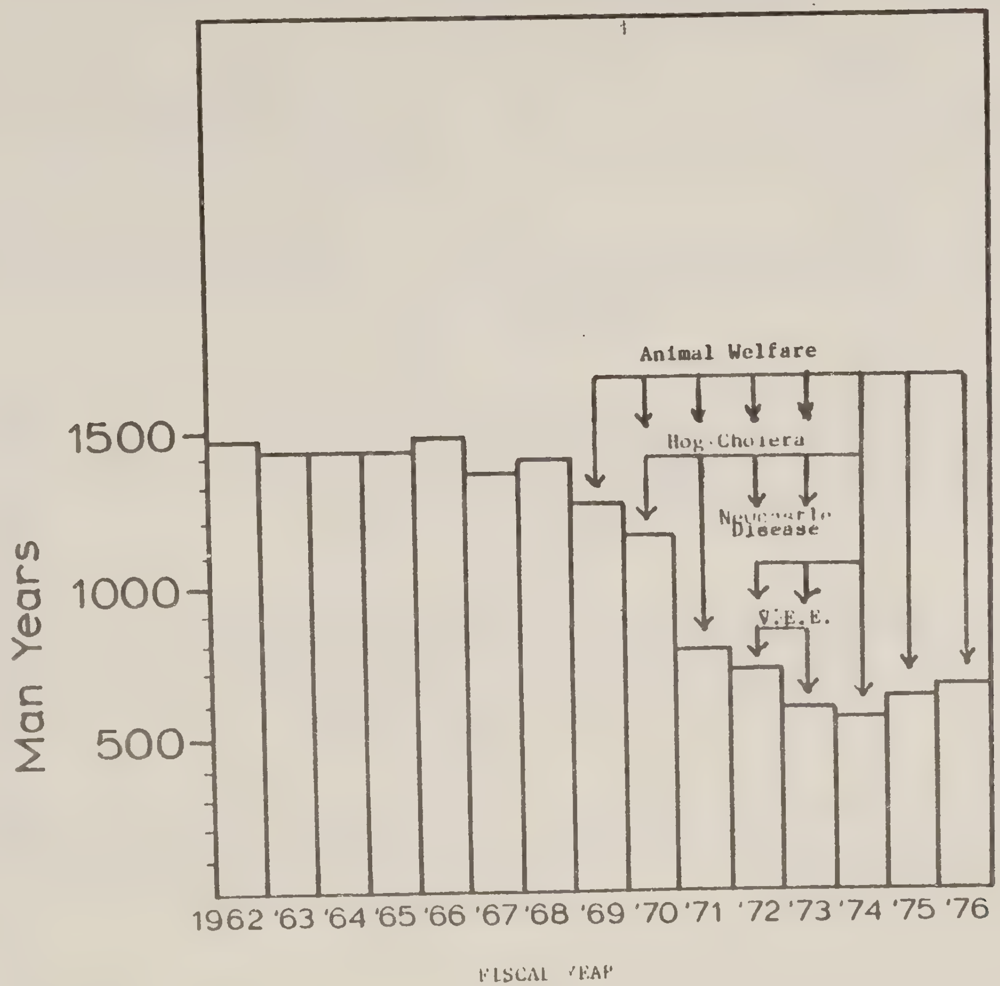


Table 1.64.1

ALABAMA
PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND
TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW
Modified Certified State

Year	Cow Years	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	1,046,000	317,702	239,335	$ .30	$ .22	73%
1955	1,051,000	1,054,251	191,334	1.00	.18	18%
1956	1,052,000	1,072,516	188,514	1.01	.17	16%
1957	1,047,000	1,354,587	202,254	1.29	.19	14%
1958	1,048,000	1,086,120	196,882	1.03	.18	17%
1959	1,059,000	986,863	195,304	.93	.18	19%
1960	939,000	990,003	250,195	1.05	.26	24%
1961	931,000	1,942,377	965,253	2.08	1.03	49%
1962	951,000	1,630,247	571,804	1.71	.60	35%
1963	977,000	1,811,619	776,240	1.85	.79	42%
1964	986,000	2,178,379	909,585	2.20	.92	41%
1965	994,000	2,232,056	905,193	2.24	.91	40%
1966	1,042,000	2,251,979	1,017,092	2.16	.97	44%
1967	1,007,000	1,822,343	913,176	1.80	.90	50%
1968	1,029,000	1,724,293	834,985	1.67	.81	48%
1969	1,059,000	1,604,279	783,236	1.51	.73	48%
1970	1,048,000	1,586,883	831,493	1.51	.79	52%
1971	1,049,000	1,566,670	900,864	1.49	.85	57%
1972	1,071,000	1,702,136	859,106	1.58	.80	50%
1973	1,115,000	1,730,884	846,262	1.55	.75	48%
1974	1,170,000	1,617,354	746,165	1.38	.63	45%
1975	1,330,000	2,058,839	762,381	1.54	.57	37%
1976	1,400,000	2,310,753	876,856	1.65	$ .62	37%

*Financial support is standardized to 1976 dollars.

Figure 1. 64.1

Alabama

Profile of Annual Financial Support-Non-Federal and Total for Brucellosis Program According to Amount Spent Per Cow (1954-1976)

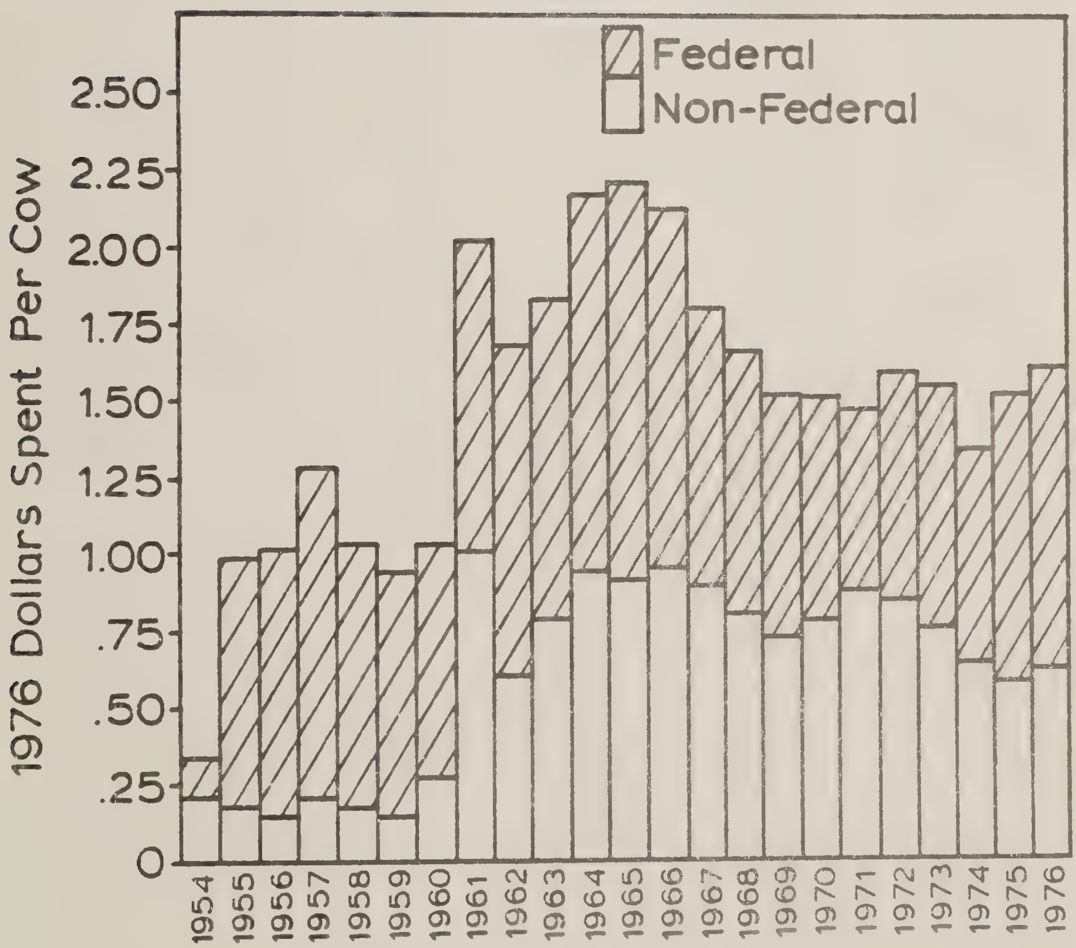


Table 1.93.1

CALIFORNIA
PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND
TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW

Certified Free State

Year	Cow Years	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	1,661,000	1,092,894	1,014,528	$ .65	$ .61	93%
1955	1,769,000	1,240,643	1,023,585	.70	.57	81%
1956	1,792,000	1,133,347	747,682	.63	.41	65%
1957	1,802,000	1,223,142	743,020	.67	.41	61%
1958	1,754,000	2,767,115	1,524,089	1.57	.86	54%
1959	1,796,000	4,485,677	2,910,753	2.49	1.62	65%
1960	1,752,000	3,435,279	1,994,235	1.96	1.13	57%
1961	1,750,000	3,941,983	2,182,516	2.25	1.24	55%
1962	1,739,000	2,872,520	1,633,695	1.65	.93	56%
1963	1,735,000	2,596,782	1,614,172	1.49	.93	62%
1964	1,794,000	3,034,408	1,814,830	1.69	1.01	59%
1965	1,823,000	3,218,046	1,880,747	1.76	1.03	58%
1966	1,853,000	2,877,773	1,784,844	1.55	.96	61%
1967	1,884,000	2,692,788	1,722,519	1.42	.91	64%
1968	1,852,000	2,494,670	1,553,460	1.34	.83	61%
1969	1,821,000	2,214,200	1,495,897	1.21	.82	67%
1970	1,734,000	2,199,560	1,469,562	1.26	.84	66%
1971	1,712,000	1,357,477	838,331	.79	.48	60%
1972	1,672,000	1,153,058	696,324	.68	.41	60%
1973	1,704,000	1,188,591	894,695	.69	.52	75%
1974	1,864,000	1,896,185	1,670,922	1.01	.89	88%
1975	1,897,000	2,843,530	2,372,830	1.49	1.25	83%
1976	1,820,000	2,574,634	1,879,536	1.41	$1.03	73%

*Financial support is standardized to 1976 dollars.

Figure 1.93.1

California

Profile of Annual Financial Support - Non-Federal and Total for Brucellosis Program According to Amount Spent Per Cow (1954-1976)

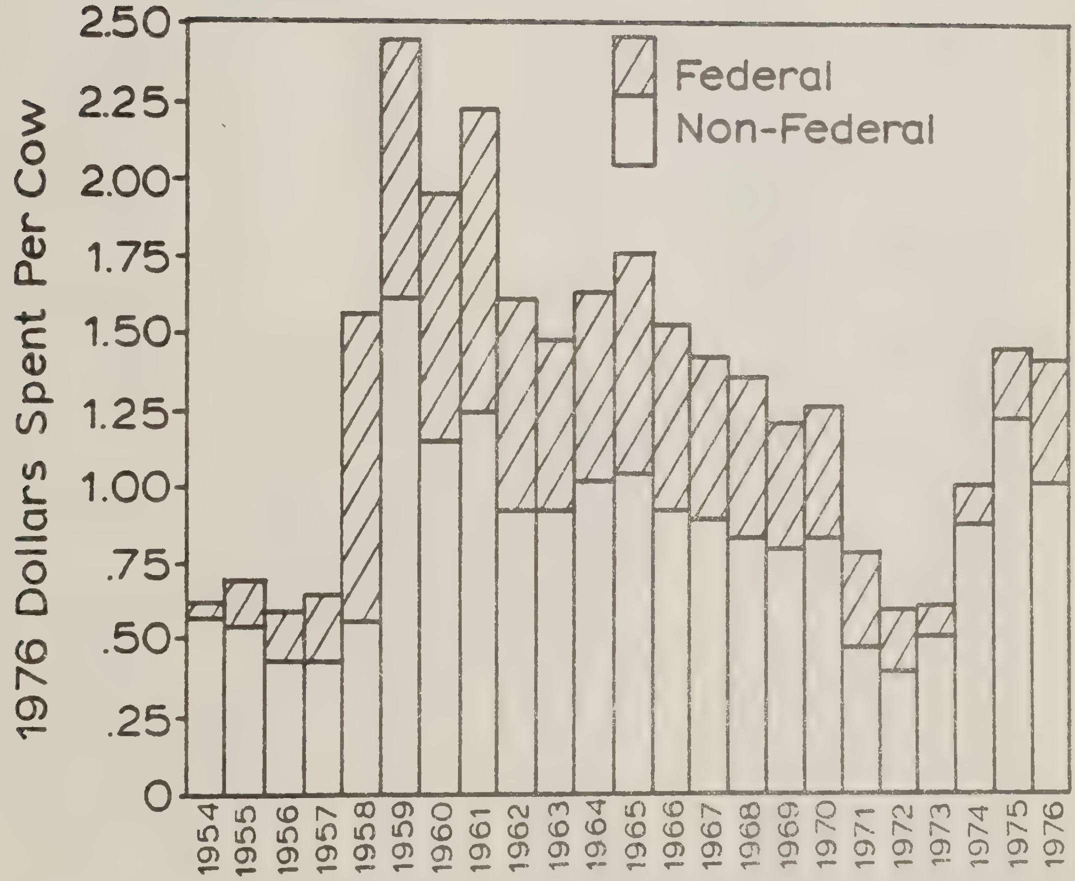


Table 1.58.1

FLORIDA

PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW

Modified Certified State

Year	Cow Years	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	1,035,000	402,422	199,093	$ .38	$ .19	50%
1955	1,001,000	677,918	250,605	.67	.25	37%
1956	989,000	1,211,731	557,772	1.22	.56	45%
1957	1,029,000	1,332,600	546,664	1.29	.53	41%
1958	1,020,000	1,459,789	731,508	1.43	.71	49%
1959	962,000	1,198,933	571,023	1.24	.59	47%
1960	954,000	1,045,815	653,792	1.09	.68	62%
1961	985,000	1,433,814	850,683	1.45	.86	59%
1962	980,000	1,674,462	828,694	1.70	.84	49%
1963	995,00	1,748,151	907,878	1.75	.91	52%
1964	1,046,000	1,666,686	870,236	1.59	.83	52%
1965	1,084,000	1,719,964	869,063	1.58	.80	50%
1966	1,089,000	1,812,005	869,734	1.66	.79	47%
1967	1,089,000	3,370,299	1,661,804	3.09	1.52	49%
1968	1,120,000	3,697,248	1,669,440	3.30	1.49	45%
1969	1,180,000	3,158,284	1,531,567	2.67	1.29	48%
1970	1,230,000	3,164,830	1,634,987	2.57	1.32	51%
1971	1,220,000	3,041,511	1,604,650	2.49	1.31	52%
1972	1,266,000	3,405,901	1,716,350	2.69	1.35	50%
1973	1,336,000	3,960,109	1,783,466	2.96	1.33	49%
1974	1,494,000	3,205,144	1,653,795	2.14	1.10	51%
1975	1,670,000	3,297,349	1,687,292	1.97	1.01	51%
1976	1,615,000	4,215,716	1,748,216	2.61	$1.08	41%

*Financial support is standardized to 1976 dollars.

Figure 1.58.1

Florida

Profile of Annual Financial Support-Non-Federal and Total for Brucellosis Program According to Amount Spent Per Cow

(1954-1976)

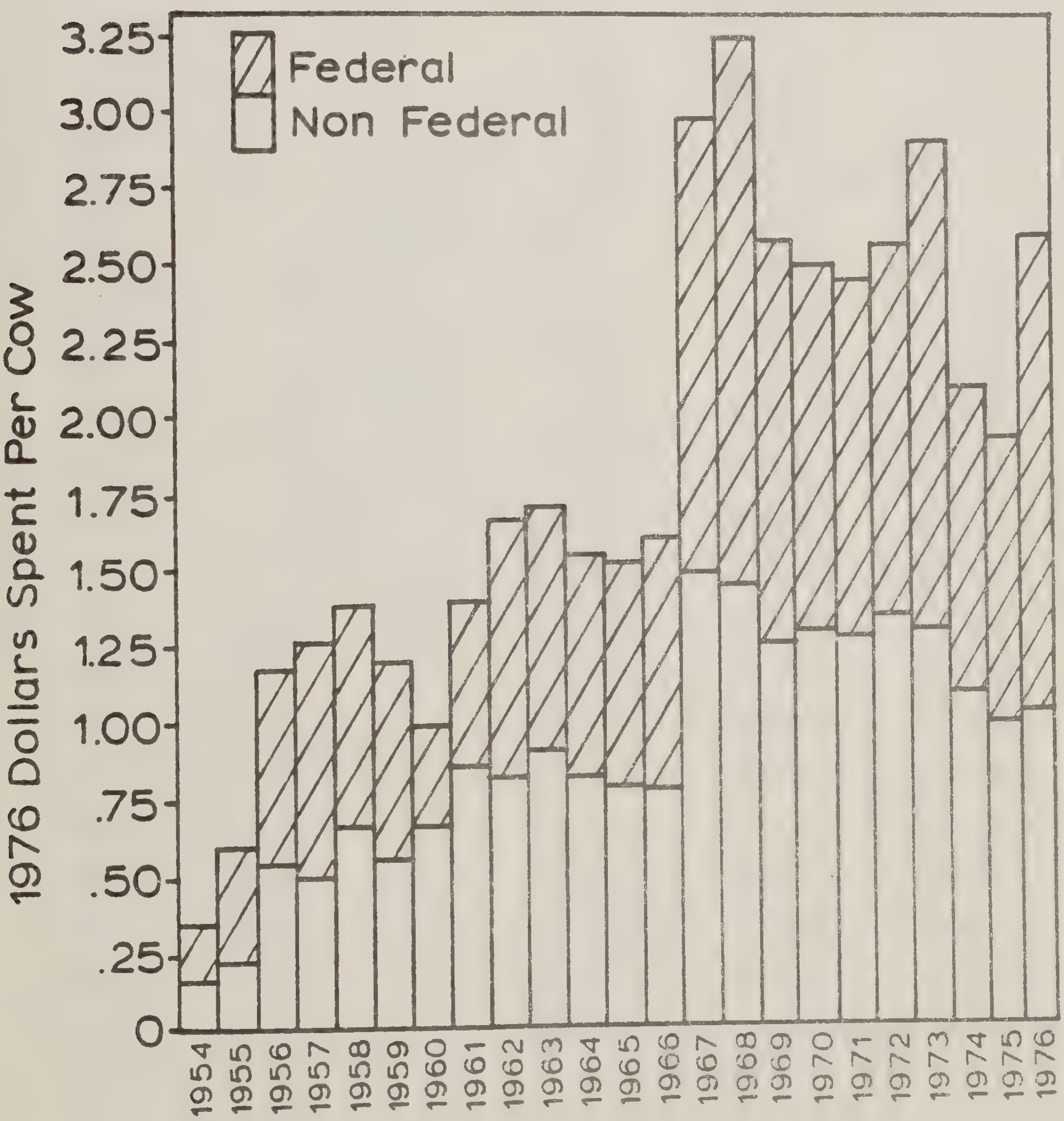


Table 1.57.1

GEORGIA
PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND
TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW
Modified Certified State

Year	Cow Years	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	750,000	682,000	582,453	$ .90	$ .77	85%
1955	864,000	1,098,471	359,283	1.27	.41	32%
1956	849,000	1,217,565	427,926	1.43	.50	34%
1957	841,000	2,224,303	833,462	2.64	.99	37%
1958	838,000	3,041,247	1,291,173	3.62	1.54	42%
1959	833,000	2,643,389	1,290,761	3.17	1.54	48%
1960	748,000	2,166,063	1,180,723	2.89	1.50	52%
1961	741,000	2,360,390	1,346,040	3.18	1.81	56%
1962	766,000	2,183,787	1,122,505	2.85	1.46	51%
1963	772,000	2,092,974	1,106,417	2.71	1.43	52%
1964	818,000	1,898,307	916,660	2.32	1.12	48%
1965	831,000	2,033,995	1,168,800	2.44	1.40	57%
1966	935,000	1,874,770	1,070,330	2.00	1.14	57%
1967	917,000	1,943,356	1,143,487	2.11	1.24	58%
1968	942,000	1,655,884	882,274	1.75	.93	53%
1969	963,000	1,902,814	1,332,371	1.97	1.38	70%
1970	962,000	1,915,427	1,330,554	1.99	1.38	69%
1971	1,003,000	1,607,288	890,429	1.60	.88	55%
1972	1,033,000	2,333,401	1,418,182	2.25	1.37	60%
1973	1,054,000	2,282,571	1,372,383	2.16	1.30	60%
1974	1,065,000	2,274,530	1,475,123	2.13	1.38	64%
1975	1,190,000	3,664,196	2,643,523	3.06	2.22	72%
1976	1,166,000	4,436,524	2,534,808	3.80	$2.17	57%

*Financial support is standardized to 1976 dollars.

Figure 1. 57. 1
Georgia

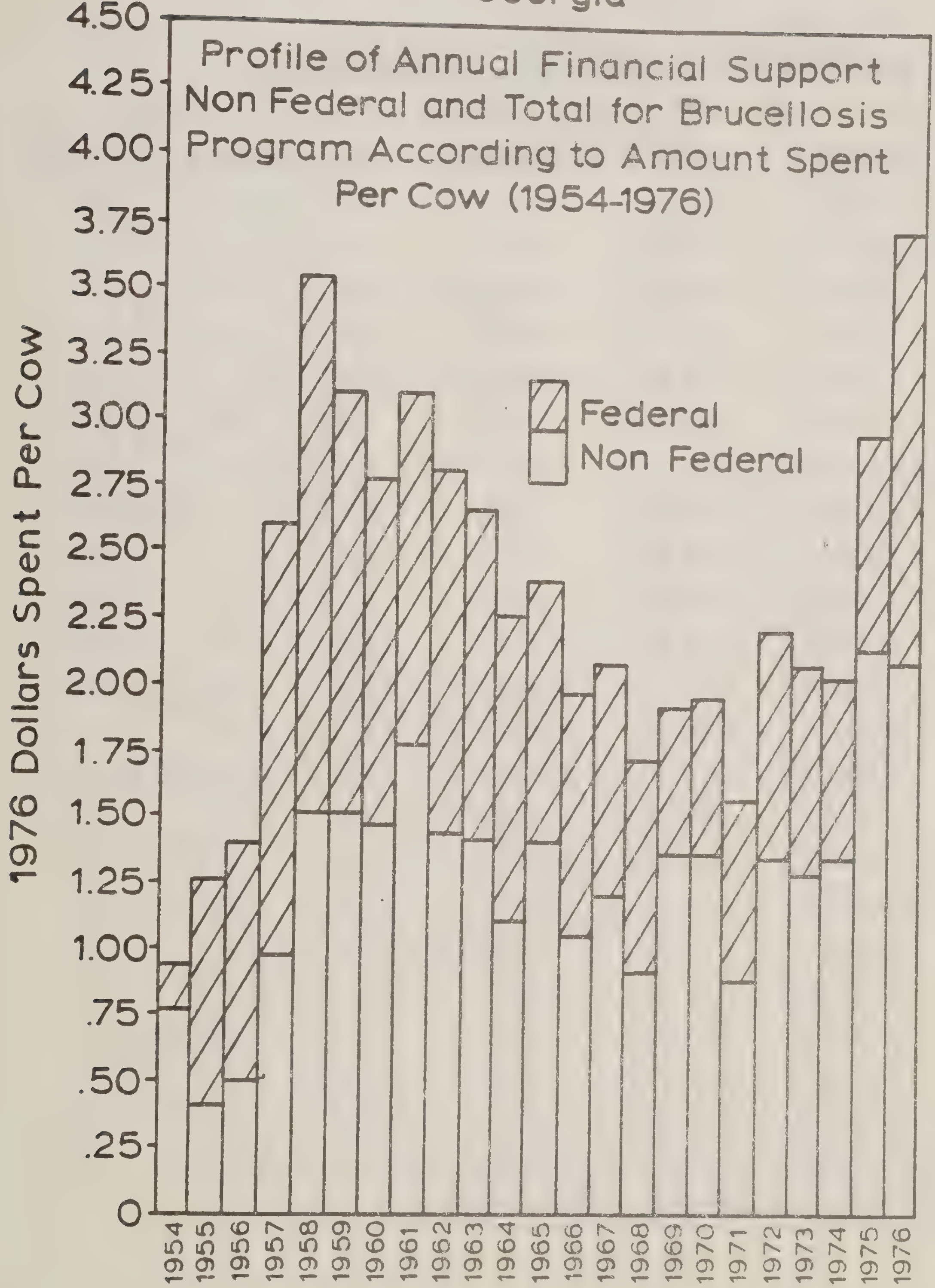


Table 1.72.1

LOUISIANA

PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW

Modified Certified State

Year	Cow Year	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	1,115,000	624,814	444,783	$ .56	$ .39	69%
1955	1,164,000	1,763,368	549,246	1.51	.47	31%
1956	1,213,000	5,101,016	2,918,131	4.20	2.40	57%
1957	1,210,000	4,600,743	2,867,512	3.80	2.36	62%
1958	1,198,000	4,049,897	1,817,136	3.38	1.51	44%
1959	1,160,000	2,302,461	706,999	1.98	.60	30%
1960	1,081,000	1,974,373	749,933	1.82	.69	37%
1961	1,108,000	2,095,734	786,975	1.89	.71	37%
1962	1,122,000	2,020,209	913,679	1.80	.81	45%
1963	1,123,000	1,970,584	896,324	1.75	.79	45%
1964	1,191,000	2,186,843	1,011,564	1.83	.84	45%
1965	1,171,000	2,328,119	1,035,031	1.98	.88	44%
1966	1,184,000	2,212,392	1,071,757	1.86	.90	48%
1967	1,125,000	3,930,971	1,324,899	3.49	1.17	33%
1968	1,089,000	3,924,956	1,394,490	3.60	1.28	35%
1969	1,099,000	3,655,831	1,331,440	3.32	1.21	36%
1970	1,081,000	2,832,303	1,107,771	2.62	1.02	38%
1971	1,056,000	2,247,422	1,092,655	2.12	1.03	48%
1972	1,042,000	2,662,693	1,109,013	2.55	1.06	41%
1973	1,064,000	2,604,383	1,111,125	2.44	1.04	42%
1974	1,043,000	2,466,300	1,045,531	2.36	1.00	42%
1975	1,043,000	2,824,345	1,042,751	2.70	.99	36%
1976	1,090,000	2,895,664	1,116,251	2.65	$1.02	38%

*Financial support is standardized to 1976 dollars.

Figure 1. 72.1
Louisiana

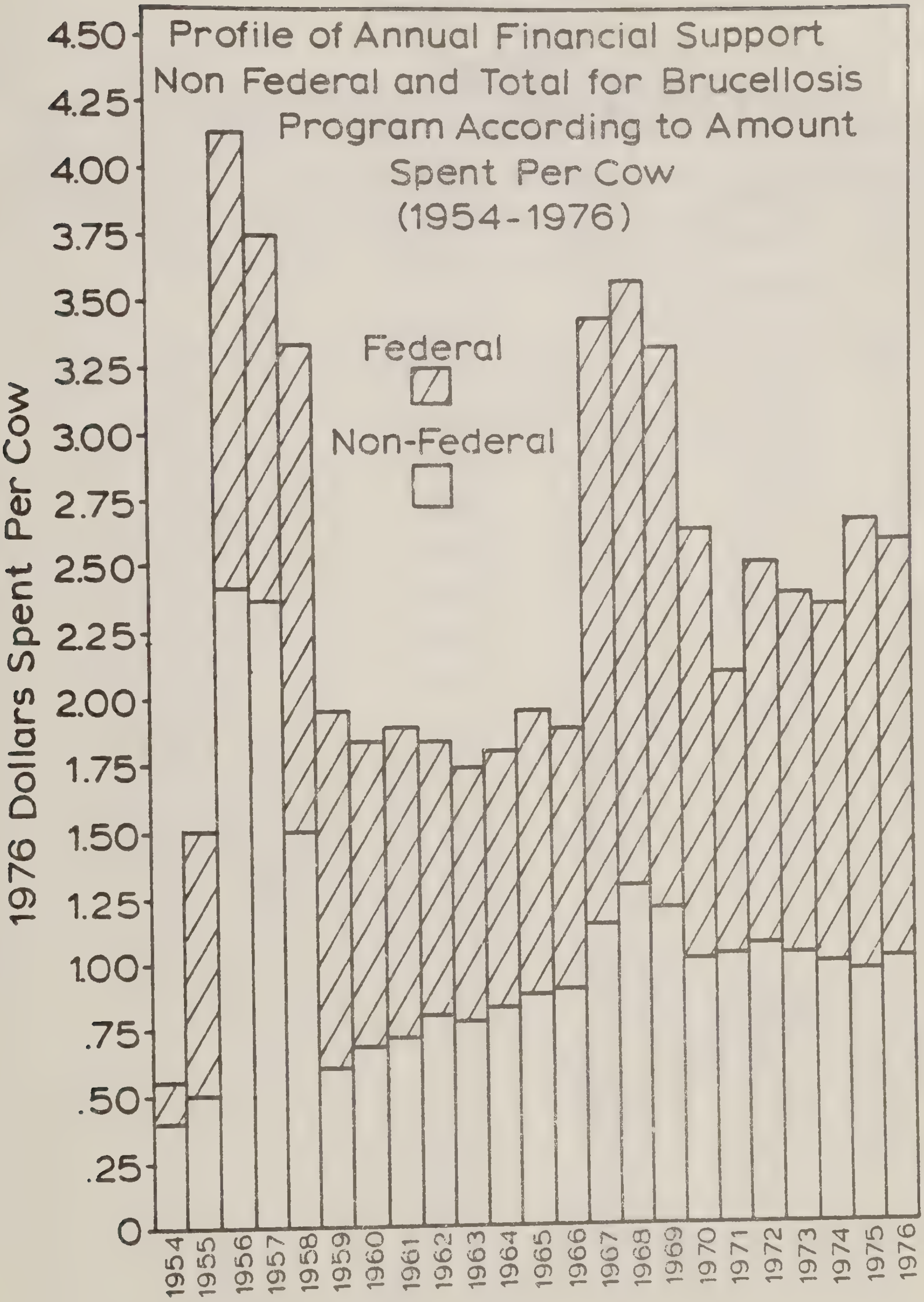


Table 1.41.1

MINNESOTA
PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND
TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW
Certified Free State

Year	Cow Years	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	1,820,000	3,301,981	2,435,714	$1.81	$1.33	73%
1955	1,830,000	5,737,042	2,058,968	3.13	1.12	35%
1956	1,840,000	5,196,295	1,597,547	2.82	.86	30%
1957	1,847,000	3,187,553	1,302,515	1.72	.70	40%
1958	1,781,000	2,826,998	994,639	1.58	.55	34%
1959	1,749,000	2,527,605	918,337	1.44	.52	36%
1960	1,741,000	2,293,648	1,135,124	1.31	.65	49%
1961	1,777,000	3,094,512	1,842,835	1.74	1.03	59%
1962	1,818,000	2,631,037	1,672,468	1.44	.91	63%
1963	1,838,000	2,425,845	1,460,986	1.31	.79	60%
1964	1,889,000	2,594,028	1,657,106	1.37	.87	63%
1965	1,905,000	2,554,961	1,451,105	1.34	.76	56%
1966	1,776,000	2,219,768	1,296,903	1.24	.73	58%
1967	1,717,000	1,792,093	981,533	1.04	.57	54%
1968	1,699,000	2,129,072	1,418,653	1.25	.83	66%
1969	1,676,000	1,711,755	1,038,693	1.02	.61	54%
1970	1,582,000	1,721,620	1,021,689	1.08	.64	59%
1971	1,517,000	1,578,917	965,453	1.04	.63	60%
1972	1,518,000	1,370,299	850,060	.90	.56	62%
1973	1,528,000	1,326,512	819,395	.86	.53	61%
1974	1,608,000	1,337,224	924,580	.83	.57	68%
1975	1,625,000	1,253,112	828,961	.77	.51	66%
1976	1,641,000	961,683	557,667	.58	$ .33	56%

*Financial support is standardized to 1976 dollars.

Figure 1.41.1

Minnesota

Profile of Annual Financial Support-Non-Federal and Total for Brucellosis Program According to Amount Spent Per Cow

(1954-1976)

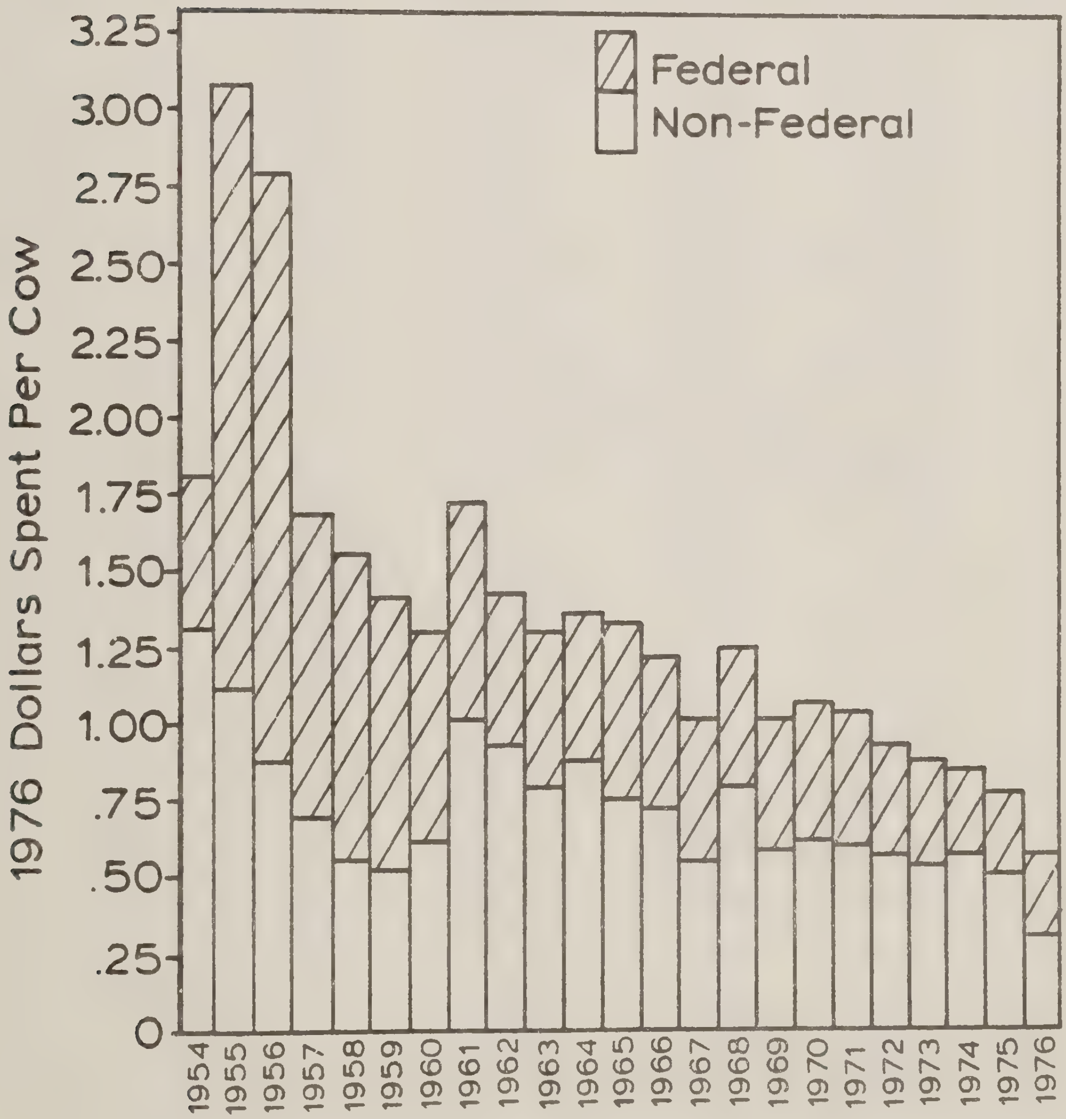


Table 1.43.1

MISSOURI

PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW

Modified Certified State

Year	Cow Years	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	2,039,000	567,627	463,845	$ .27	$ .22	81%
1955	2,011,000	2,003,201	241,863	.99	.12	12%
1956	1,970,000	3,564,013	1,493,132	1.80	.75	41%
1957	1,928,000	3,809,120	1,441,767	1.97	.74	37%
1958	1,834,000	3,689,738	1,958,978	2.01	1.06	52%
1959	1,930,000	3,772,437	2,279,030	1.45	1.18	60%
1960	1,858,000	2,421,344	1,232,010	1.30	.66	50%
1961	1,878,000	3,178,718	2,089,280	1.69	1.11	65%
1962	1,943,000	2,818,459	1,822,758	1.45	.93	64%
1963	1,993,000	2,703,894	1,687,835	1.35	.84	62%
1964	2,029,000	2,497,511	1,476,844	1.23	.72	58%
1965	2,074,000	2,964,562	1,969,210	1.42	.94	66%
1966	2,115,000	3,107,049	2,063,866	1.46	.97	66%
1967	2,151,000	2,800,391	1,788,368	1.30	.83	63%
1968	2,208,000	2,866,077	1,944,535	1.29	.88	68%
1969	2,197,000	2,694,383	1,966,598	1.22	.89	72%
1970	2,290,000	2,667,388	1,796,860	1.16	.78	67%
1971	2,260,000	2,479,465	1,959,784	1.09	.86	78%
1972	2,418,000	2,744,828	2,134,540	1.13	.88	77%
1973	2,580,000	2,459,905	1,930,475	.95	.74	77%
1974	3,040,000	1,613,403	939,849	.53	.30	56%
1975	3,070,000	1,765,452	1,015,372	.57	.33	57%
1976	3,000,000	2,124,159	1,343,893	.70	$ .44	62%

*Financial support is standardized to 1976 dollars.

Figure 1.43.1

Missouri

Profile of Annual Financial Support-Non-Federal and Total for Brucellosis Program According to Amount Spent Per Cow

(1954-1976)

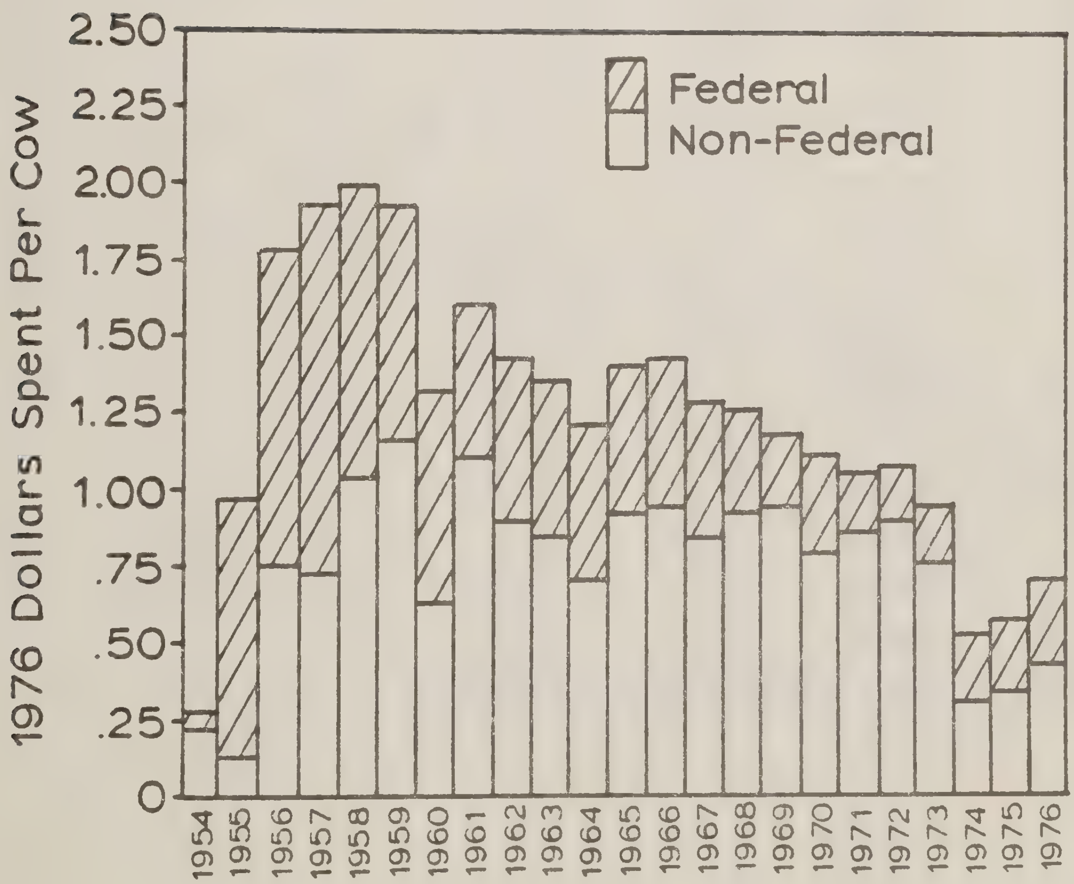


Table 1.21.1

NEW YORK
PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND
TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW

Certified Free State

Year	Cow Years	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	1,527,000	2,251,447	2,187,907	$1.47	$1.43	97%
1955	1,527,000	2,250,938	2,181,420	1.47	1.42	96%
1956	1,547,000	2,652,326	2,476,858	1.71	1.60	93%
1957	1,521,000	2,681,372	2,235,504	1.76	1.46	82%
1958	1,473,000	2,440,796	2,038,316	1.65	1.38	83%
1959	1,434,000	2,713,046	2,259,262	1.89	1.57	83%
1960	1,409,000	2,138,036	1,731,475	1.51	1.22	80%
1961	1,433,000	1,884,010	1,427,277	1.31	.99	75%
1962	1,439,000	2,255,749	1,823,889	1.56	1.26	80%
1963	1,425,000	2,058,560	1,549,841	1.44	1.08	75%
1964	1,436,000	1,886,565	1,434,421	1.31	.99	75%
1965	1,376,000	1,930,213	1,453,319	1.40	1.05	75%
1966	1,311,000	1,785,689	1,327,790	1.36	1.01	74%
1967	1,246,000	1,723,250	1,425,591	1.38	1.14	82%
1968	1,226,000	1,623,348	1,309,834	1.32	1.06	80%
1969	1,189,000	1,511,973	1,197,393	1.27	1.00	78%
1970	1,187,000	1,408,314	1,081,338	1.18	.91	77%
1971	1,061,000	1,166,810	991,437	1.09	.93	85%
1972	1,025,000	1,047,142	899,874	1.02	.86	84%
1973	1,020,000	998,457	816,326	.97	.80	82%
1974	1,015,000	412,094	233,141	.40	.22	55%
1975	1,045,000	899,905	725,009	.86	.69	80%
1976	1,046,000	931,940	702,013	.89	$ .67	75%

*Financial support is standardized to 1976 dollars.

Figure 1. 21.1

New York

Profile of Annual Financial Support-Non-Federal and Total-for Brucellosis Program According to Amount Spent Per Cow

(1954-1976)

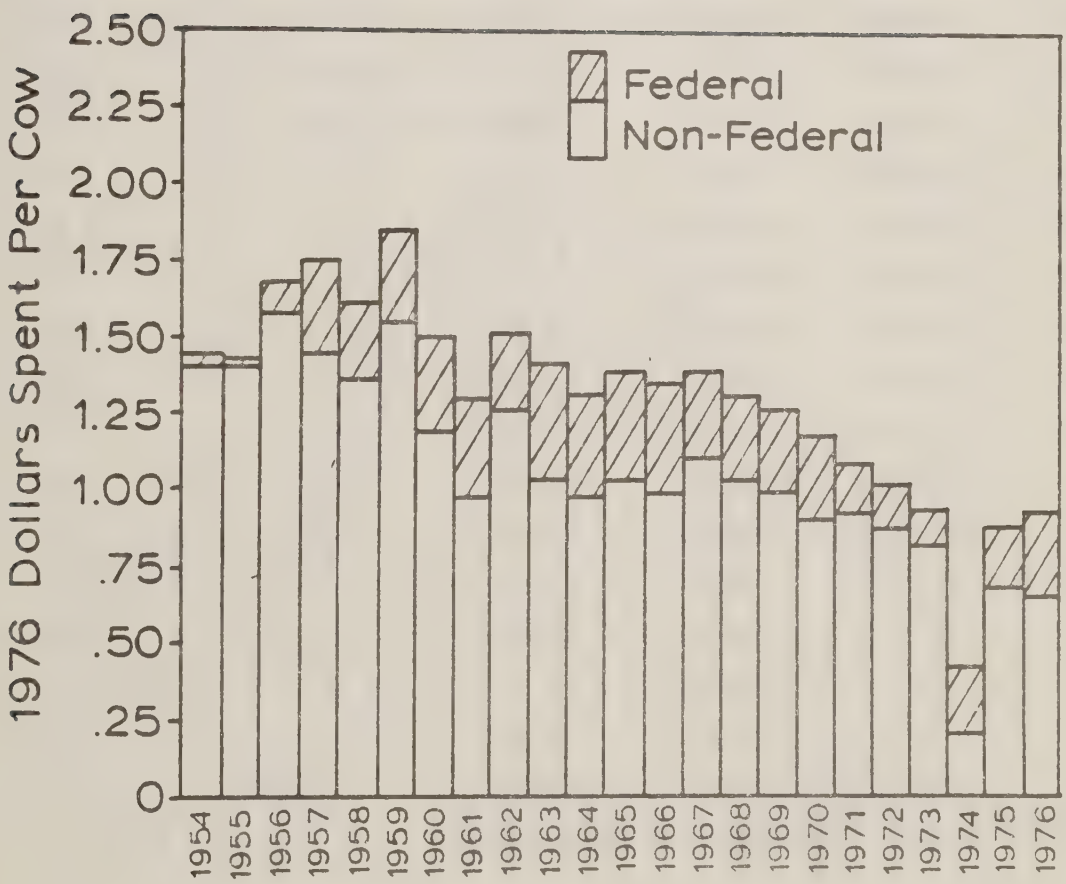


Table 1.55.1

NORTH CAROLINA
PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND
TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW
Certified Free State

Year	Cow Years	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	542,000	497,773	355,826	$ .91	$ .65	71%
1955	576,000	417,746	196,649	.72	.34	47%
1956	576,000	510,949	176,574	.88	.30	34%
1957	579,000	641,000	257,837	1.10	.44	40%
1958	585,000	611,370	259,544	1.04	.44	42%
1959	598,000	639,809	257,463	1.06	.43	40%
1960	507,000	732,277	374,331	1.44	.73	50%
1961	499,000	927,838	480,047	1.85	.96	51%
1962	505,000	958,953	507,857	1.89	1.00	52%
1963	504,000	1,008,964	574,797	2.00	1.14	57%
1964	521,000	994,140	588,691	1.90	1.12	58%
1965	514,000	1,041,540	613,363	2.02	1.19	58%
1966	530,000	1,061,494	613,777	2.00	1.15	57%
1967	542,000	1,048,699	603,207	1.93	1.11	57%
1968	541,000	1,002,255	563,789	1.85	1.04	56%
1969	544,000	908,347	476,350	1.66	.87	52%
1970	572,000	1,001,750	494,015	1.75	.86	49%
1971	552,000	656,544	494,339	1.18	.89	75%
1972	506,000	586,579	436,192	1.15	.86	74%
1973	525,000	560,839	403,647	1.06	.76	71%
1974	539,000	559,886	356,960	1.03	.66	64%
1975	568,000	516,579	338,366	.90	.59	65%
1976	578,000	642,544	505,423	1.11	$ .87	78%

*Financial support is standardized to 1976 dollars.

Figure 1.55.1

North Carolina

Profile of Annual Financial Support - Non-Federal and Total for Brucellosis Program According to Amount Spent Per Cow
(1954-1976)

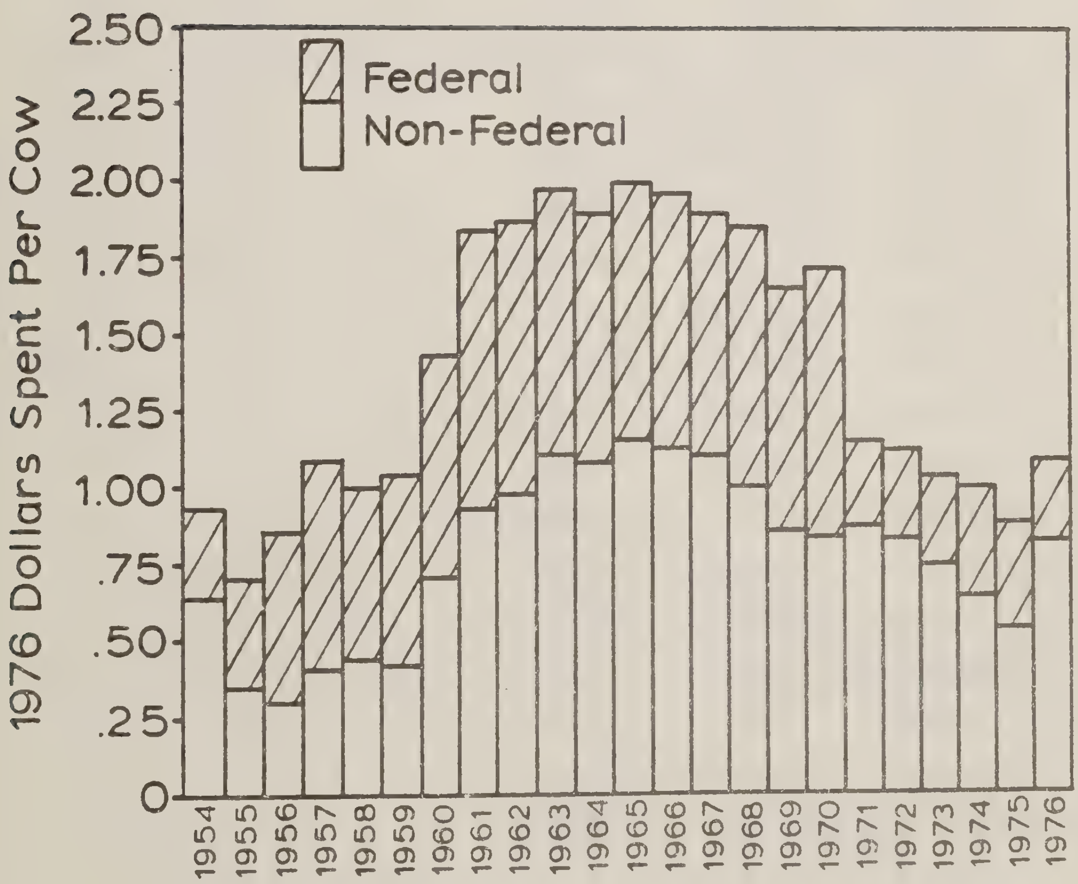


Table 1.45.1

NORTH DAKOTA

PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW

Certified Free State

Year	Cow Years	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	929,000	720,124	465,963	$ .77	$ .50	64%
1955	984,000	850,308	452,971	.86	.46	53%
1956	1,026,000	1,070,637	377,027	1.04	.36	34%
1957	1,014,000	1,191,821	364,057	1.17	.35	29%
1958	974,000	987,024	359,802	1.01	.36	35%
1959	980,000	767,570	257,801	.78	.26	33%
1960	953,000	643,606	243,181	.67	.25	37%
1961	963,000	1,115,348	619,716	1.15	.64	55%
1962	983,000	1,144,637	631,296	1.16	.64	55%
1963	1,044,000	1,183,428	682,681	1.13	.65	57%
1964	1,110,000	1,340,945	852,564	1.20	.76	63%
1965	1,167,000	1,249,808	761,660	1.07	.65	60%
1966	1,207,000	1,262,098	775,014	1.04	.64	61%
1967	1,182,000	1,182,542	759,791	1.00	.64	64%
1968	1,139,000	1,037,008	634,023	.91	.55	60%
1969	1,116,000	921,093	555,987	.82	.49	54%
1970	1,108,000	837,448	474,787	.75	.44	58%
1971	1,101,000	682,188	488,858	.61	.44	72%
1972	1,193,000	779,596	587,519	.65	.49	75%
1973	1,249,000	784,957	564,356	.62	.45	72%
1974	1,305,000	672,928	485,733	.51	.37	72%
1975	1,358,000	780,220	612,689	.57	.45	78%
1976	1,269,000	780,881	586,615	.61	$ .46	75%

*Financial support is standardized to 1976 dollars.

Figure 1.45.1

North Dakota

Profile of Annual Financial Support - Non-Federal and Total for Brucellosis Program According to Amount Spent Per Cow (1954-1976)

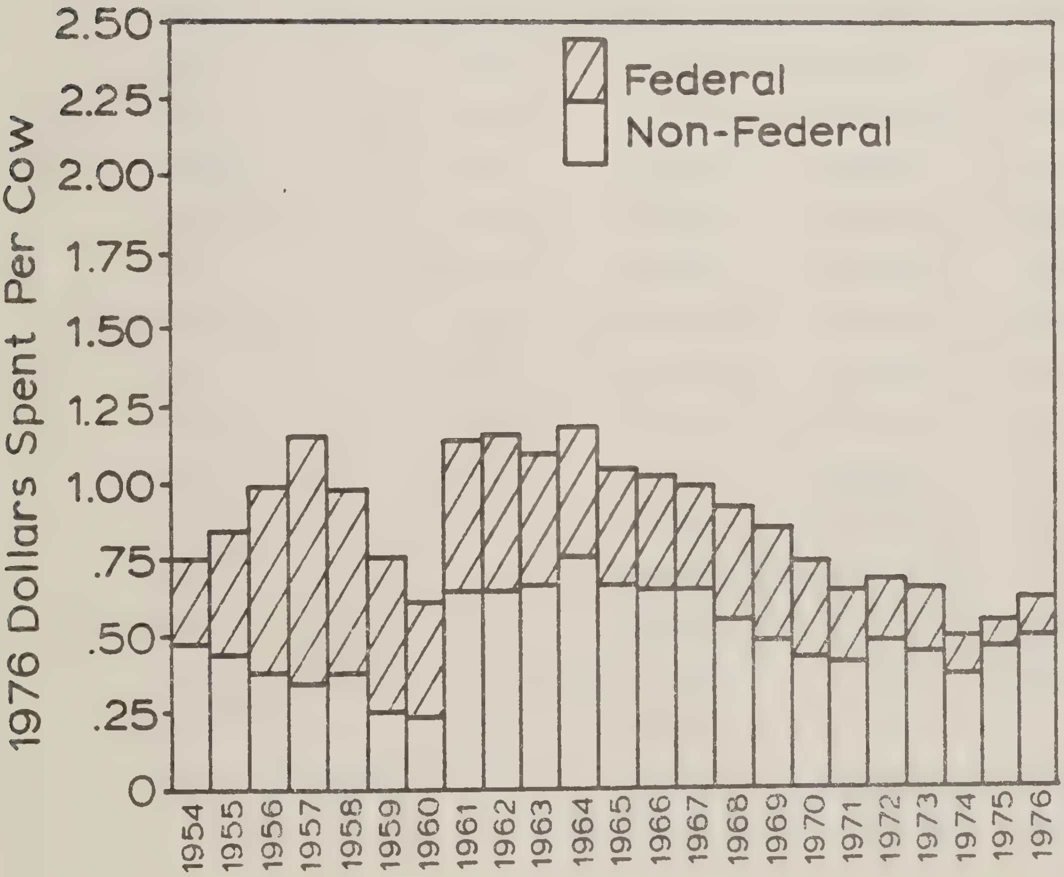


Table 1.74.1

TEXAS
PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND
TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW
Modified Certified State

Year	Cow Years	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	4,895,000	144,025	114,313	$ .02	$ .02	100%
1955	4,828,000	146,294	115,681	.03	.02	66%
1956	4,728,000	143,230	113,108	.03	.02	66%
1957	4,499,000	419,984	121,352	.09	.02	22%
1958	4,403,000	730,309	250,180	.16	.05	31%
1959	4,683,000	806,705	278,929	.17	.05	29%
1960	4,855,000	1,231,862	564,090	.25	.11	44%
1961	4,984,000	2,493,534	1,101,700	.50	.22	44%
1962	5,100,000	3,106,721	1,699,911	.60	.33	55%
1963	5,509,000	3,830,919	2,197,434	.69	.39	56%
1964	5,726,000	3,668,699	1,978,202	.64	.34	53%
1965	5,692,000	3,771,114	1,876,978	.66	.32	48%
1966	5,589,000	3,625,737	1,859,880	.64	.33	51%
1967	5,670,000	4,434,541	2,652,409	.78	.46	58%
1968	5,754,000	5,333,863	3,108,824	.92	.54	38%
1969	5,944,000	6,377,776	3,631,583	1.07	.61	57%
1970	5,937,000	6,156,150	3,053,234	1.03	.51	49%
1971	6,146,000	5,751,953	2,499,115	.93	.40	43%
1972	5,807,000	4,032,899	1,846,388	.69	.31	44%
1973	6,570,000	3,024,762	1,674,721	.46	.25	54%
1974	6,820,000	3,633,302	2,059,797	.53	.30	56%
1975	7,240,000	5,667,014	1,928,443	.78	.26	33%
1976	6,800,000	7,089,544	2,231,728	1.04	$ .32	30%

*Financial support is standardized to 1976 dollars.

Figure 1.74.1

Texas

Profile of Annual Financial Support - Non-Federal and Total for Brucellosis Program According to Amount Spent Per Cow

(1954-1976)

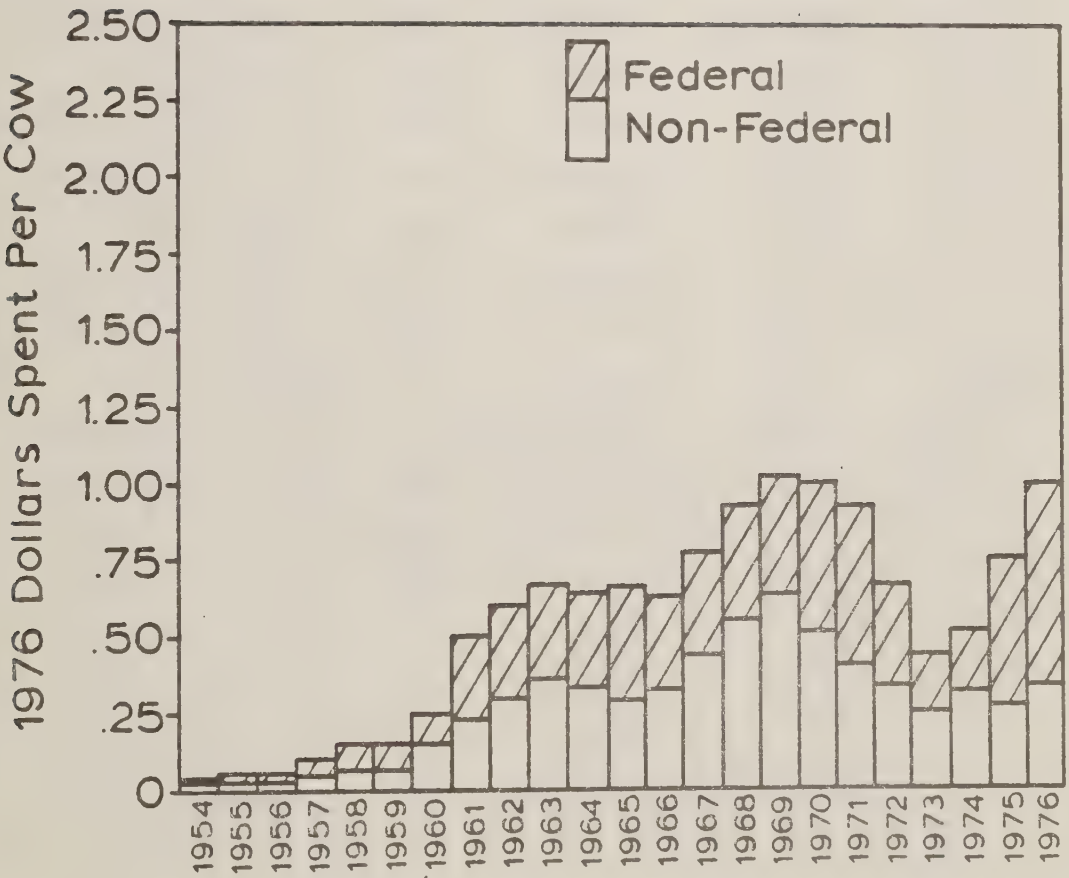


Table 1.35.1

WISCONSIN

PROFILE OF ANNUAL FINANCIAL SUPPORT*-NON-FEDERAL AND TOTAL-FOR BRUCELLOSIS PROGRAM ACCORDING TO AMOUNT SPENT PER COW

Certified Free State

Year	Cow Years	Financial Support Total	Financial Support Non-Federal	Dollars Spent/Cow Total	Dollars Spent/Cow Non-Federal	% Non-Federal Dollars Spent
1954	2,647,000	3,217,261	2,715,292	$1.21	$1.02	84%
1955	2,665,000	7,455,166	2,693,071	2.79	1.01	36%
1956	2,676,000	12,137,212	5,781,358	4.53	2.16	47%
1957	2,670,000	4,883,878	2,772,753	1.81	1.03	56%
1958	2,597,000	4,008,130	2,396,720	1.54	.92	59%
1959	2,532,000	3,736,798	2,311,021	1.47	.91	77%
1960	2,525,000	2,679,089	1,642,336	1.06	.65	61%
1961	2,525,000	2,845,639	1,573,173	1.12	.62	55%
1962	2,537,000	2,954,590	1,819,316	1.16	.71	61%
1963	2,402,000	2,940,541	1,631,652	1.22	.67	54%
1964	2,378,000	3,090,743	1,869,524	1.29	.78	60%
1965	2,378,000	3,049,574	1,804,303	1.28	.75	58%
1966	2,259,000	3,188,397	1,944,103	1.41	.86	60%
1967	2,180,000	2,461,768	1,394,608	1.12	.63	56%
1968	2,147,000	2,476,828	1,492,156	1.15	.69	60%
1969	2,094,000	2,401,225	1,753,718	1.14	.83	72%
1970	2,062,000	2,539,635	1,946,614	1.23	.94	76%
1971	1,846,000	2,686,997	2,221,874	1.45	1.20	82%
1972	1,832,000	2,262,366	1,774,557	1.23	.96	78%
1973	1,825,000	2,208,719	1,697,441	1.21	.93	76%
1974	1,796,000	2,215,447	1,708,665	1.23	.95	77%
1975	1,810,000	2,248,781	1,737,871	1.24	.96	77%
1976	1,812,000	2,565,647	2,006,206	1.41	$ 1.10	78%

*Financial support is standardized to 1976 dollars.

Figure 1.35.1
Wisconsin

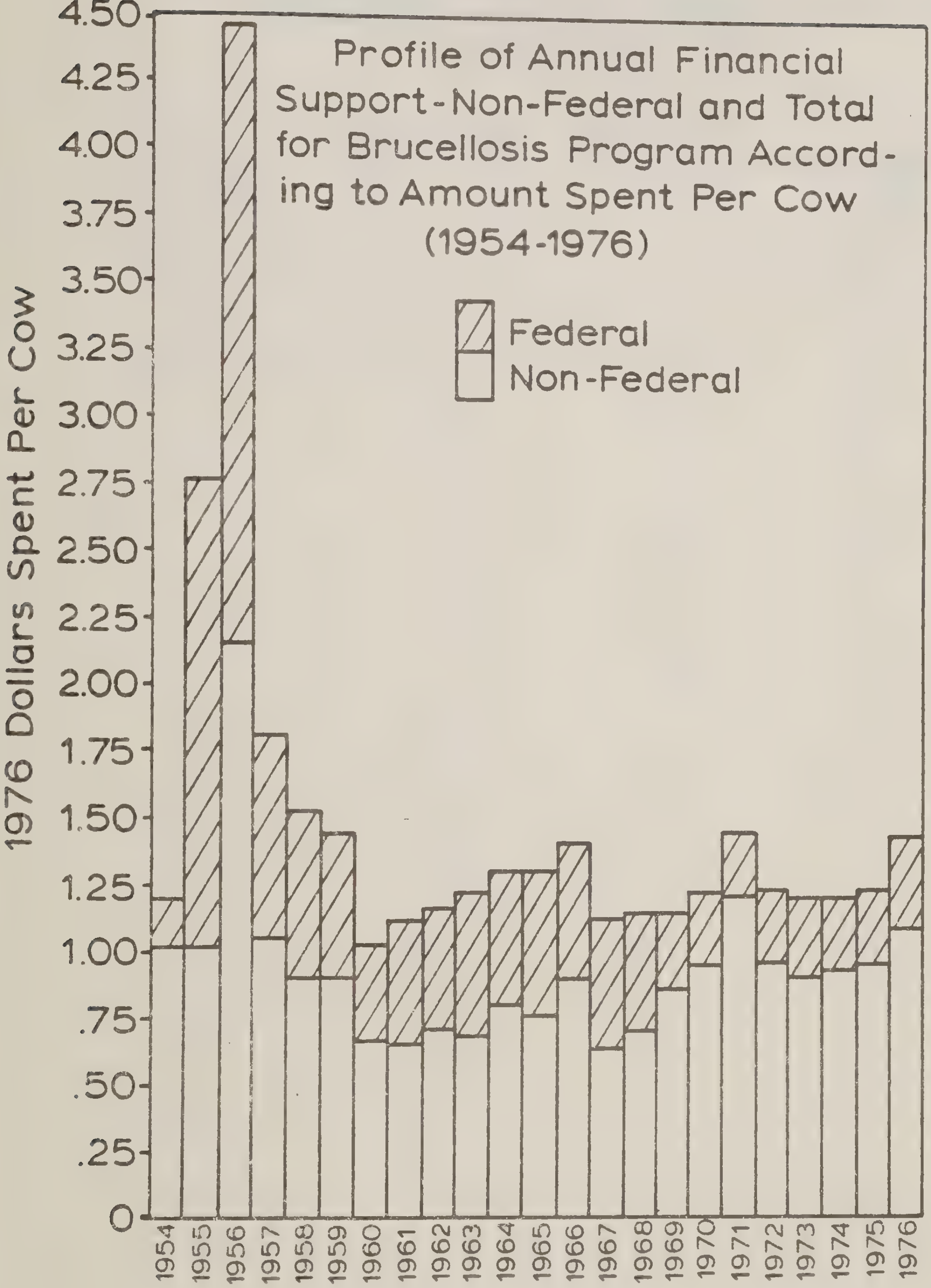


Table 1.64.2

ALABAMA

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

Modified Certified State

Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	809	405	56,591	13.97
1955	778	389	48,388	12.44
1956	772	386	59,069	15.30
1957	787	394	70,413	17.87
1958	752	376	54,009	14.36
1959	747	374	66,725	17.84
1960	761	381	71,292	18.71
1961	754	377	79,436	21.07
1962	780	390	101,839	26.11
1963	802	401	109,758	27.37
1964	833	417	107,478	25.77
1965	838	419	123,169	29.40
1966	844	422	112,310	26.61
1967	846	423	103,493	24.47
1968	860	430	86,066	20.02
1969	892	446	30,905	6.93
1970	907	454	10,258	2.26
1971	942	471	6,821	1.45
1972	980	490	5,355	1.09
1973	1,033	517	3,238	.63
1974	1,140	570	3,229	.57
1975	1,250	625	3,928	.63
1976	1,050	525	3,886	.74

Figure 1.64.2

ALABAMA
PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)
Modified Certified State

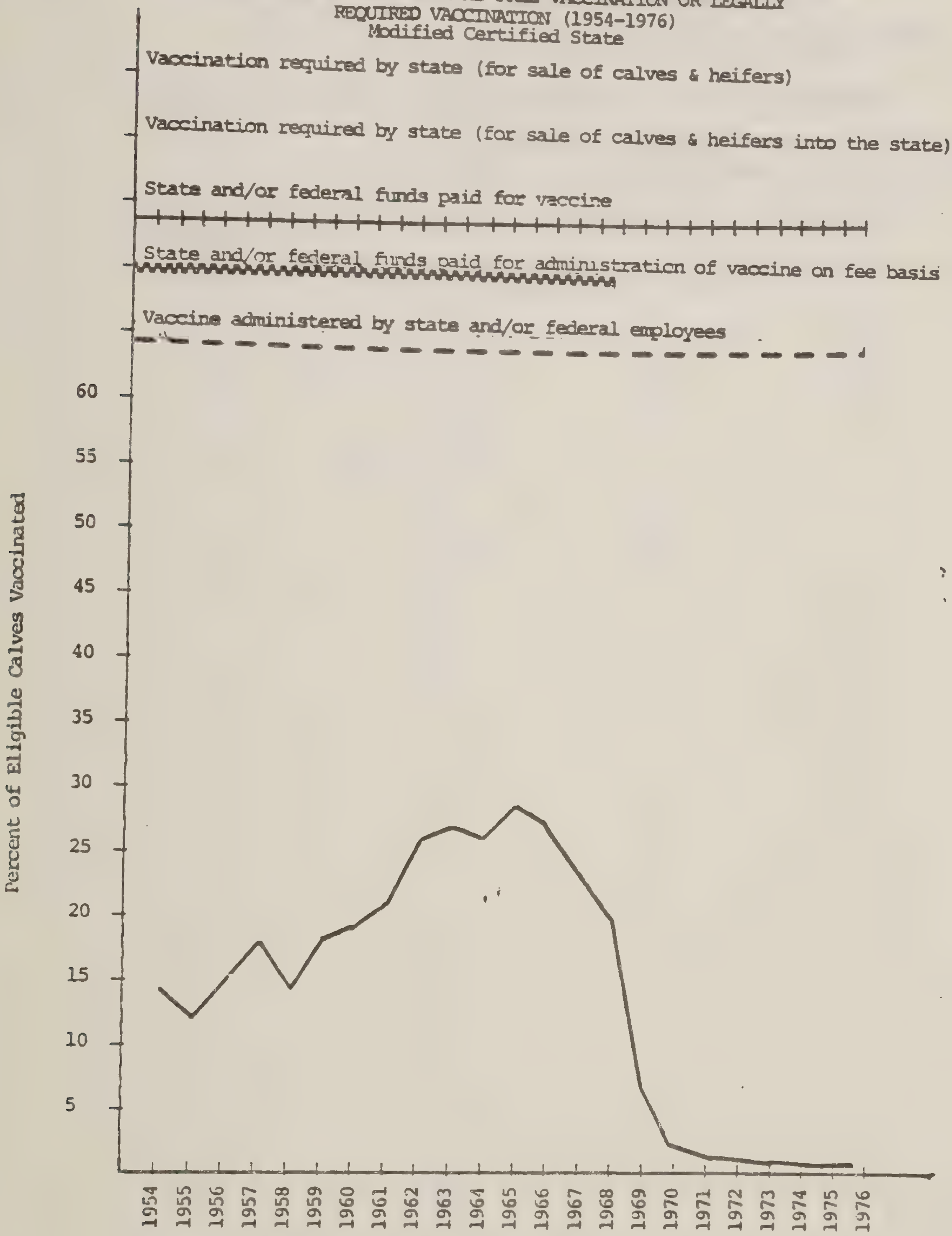


Table 1.93.2
CALIFORNIA
PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)
Certified Free State

Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	1,466	733	367,303	50.11
1955	1,521	761	351,162	46.14
1956	1,501	751	343,053	45.68
1957	1,517	759	351,675	46.33
1958	1,494	747	396,579	53.09
1959	1,507	754	439,698	58.32
1960	1,524	762	444,780	58.37
1961	1,529	765	395,614	51.71
1962	1,530	765	387,245	50.62
1963	1,526	763	378,285	49.58
1964	1,597	799	434,187	54.34
1965	1,627	814	423,435	52.02
1966	1,617	809	400,483	49.50
1967	1,632	816	394,783	48.38
1968	1,598	799	432,261	54.10
1969	1,569	785	363,615	46.32
1970	1,546	773	376,258	48.68
1971	1,539	770	270,124	35.08
1972	1,532	766	315,018	41.13
1973	1,580	790	272,282	34.47
1974	1,600	800	261,494	32.69
1975	1,620	810	296,709	36.63
1976	1,610	805	372,936	46.33

Figure 1.93.2

CALIFORNIA

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

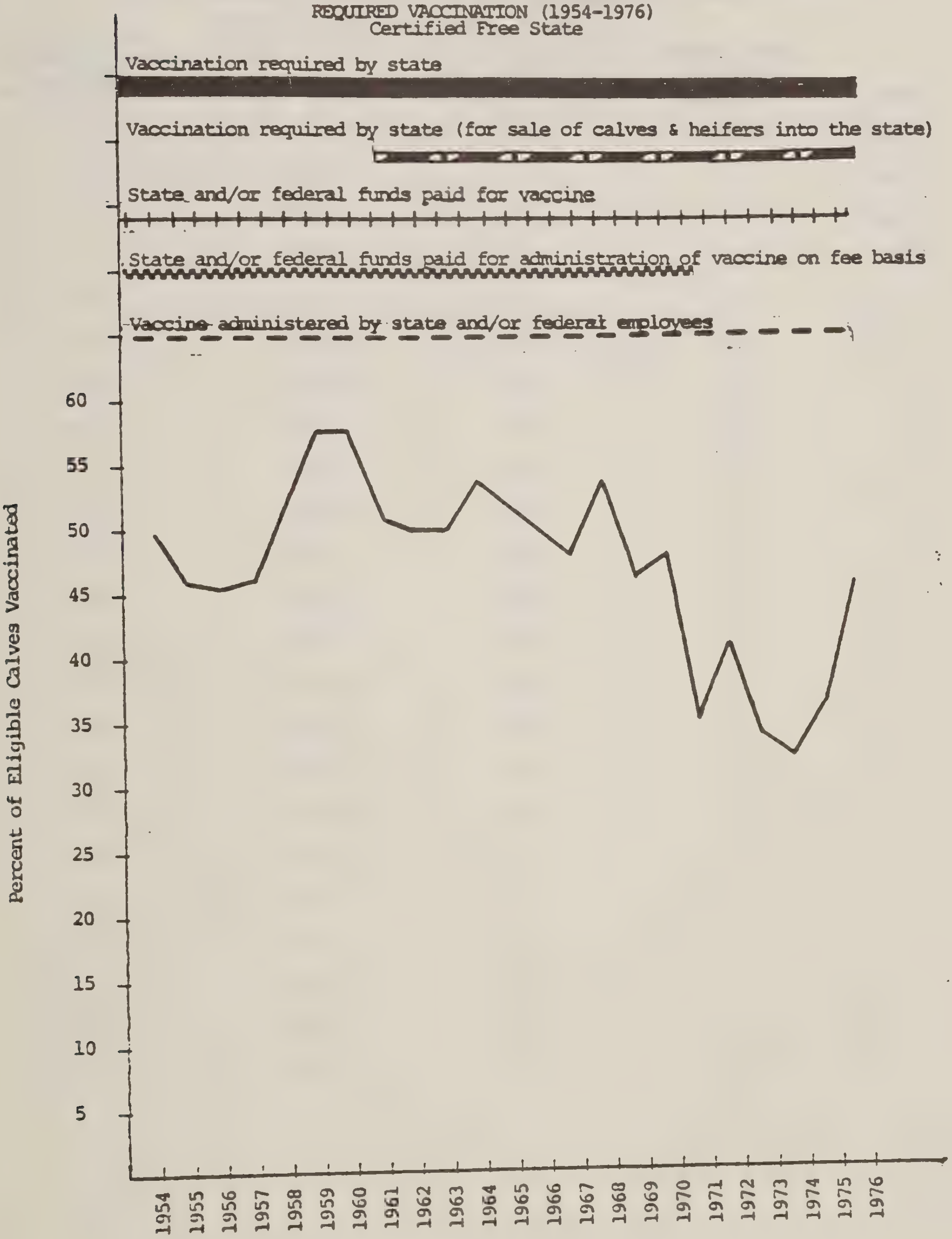


Table 1.58.2

FLORIDA

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

Modified Certified State

Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	673	337	73,239	21.73
1955	661	331	125,357	37.87
1956	673	337	63,726	18.91
1957	679	340	252,294	-
1958	663	332	103,347	31.13
1959	645	323	106,132	32.86
1960	601	301	107,334	35.66
1961	670	335	104,534	31.20
1962	725	363	115,025	31.69
1963	716	358	134,485	37.57
1964	774	387	151,054	39.03
1965	813	407	143,086	35.16
1966	806	403	141,570	35.13
1967	773	387	142,061	36.71
1968	851	426	129,422	30.38
1969	944	472	136,235	28.86
1970	1,000	500	118,094	23.62
1971	1,025	513	102,619	20.00
1972	1,087	544	99,661	18.32
1973	1,180	590	65,995	11.19
1974	1,320	660	47,827	7.25
1975	1,250	625	50,442	8.07
1976	1,170	585	71,512	12.22

Figure 1.58.2

FLORIDA

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

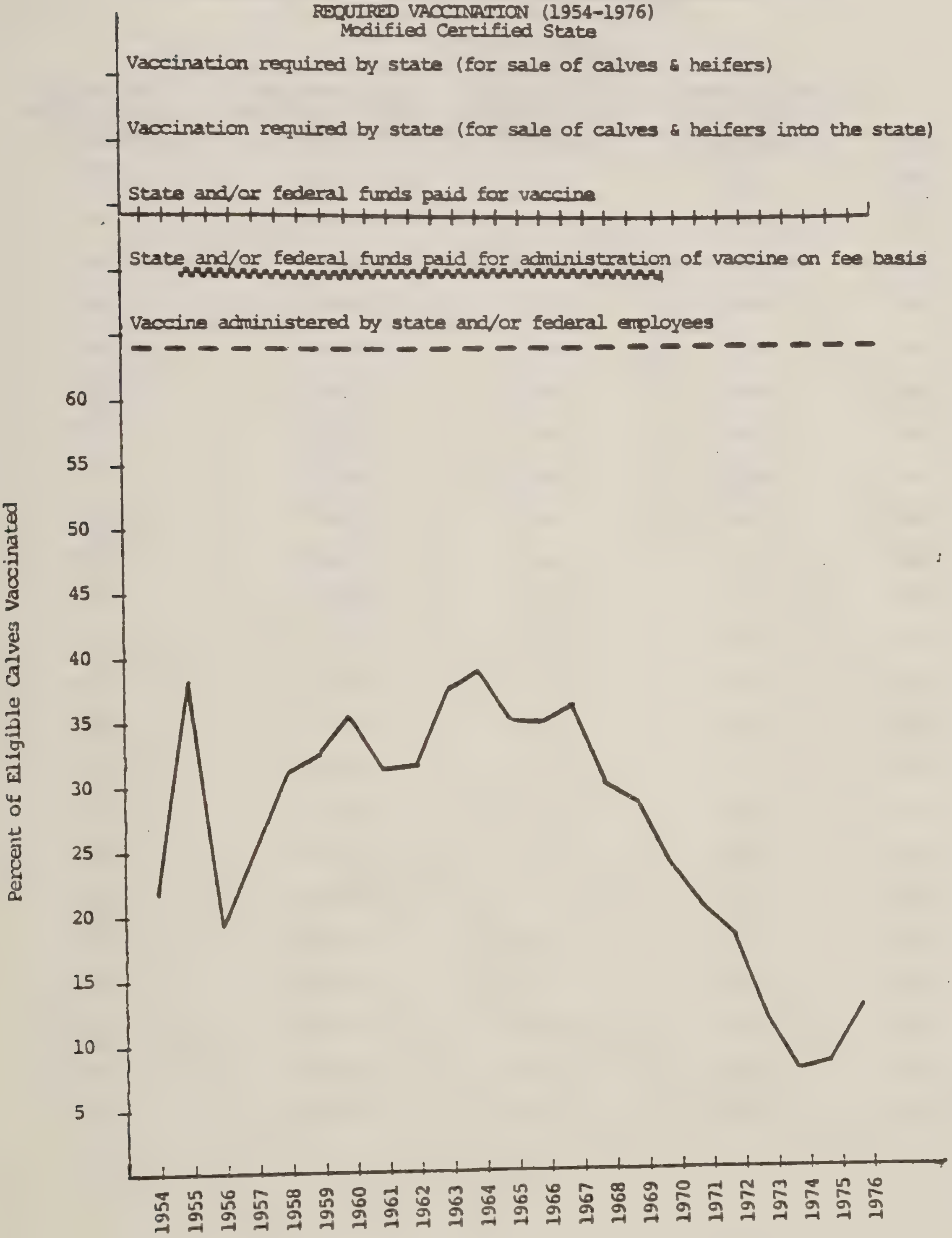


Table 1.57.2
GEORGIA
PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

Modified Certified State

Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	668	334	19,092	5.72
1955	665	333	32,916	9.88
1956	644	322	33,245	10.32
1957	654	327	40,469	12.38
1958	622	311	50,814	16.34
1959	604	302	61,156	20.25
1960	598	299	70,962	23.73
1961	612	306	66,079	21.59
1962	646	323	74,098	22.94
1963	685	343	88,109	25.69
1964	733	367	72,381	19.72
1965	756	378	39,301	10.40
1966	739	370	39,238	10.60
1967	752	376	43,843	11.66
1968	782	391	41,297	10.56
1969	819	410	29,462	7.19
1970	850	425	22,525	5.30
1971	893	447	23,948	5.36
1972	911	456	19,466	4.27
1973	920	460	16,699	3.63
1974	940	470	15,761	3.35
1975	1,010	505	17,985	3.56
1976	910	455	15,082	3.31

Figure 1.57.2

GEORGIA

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

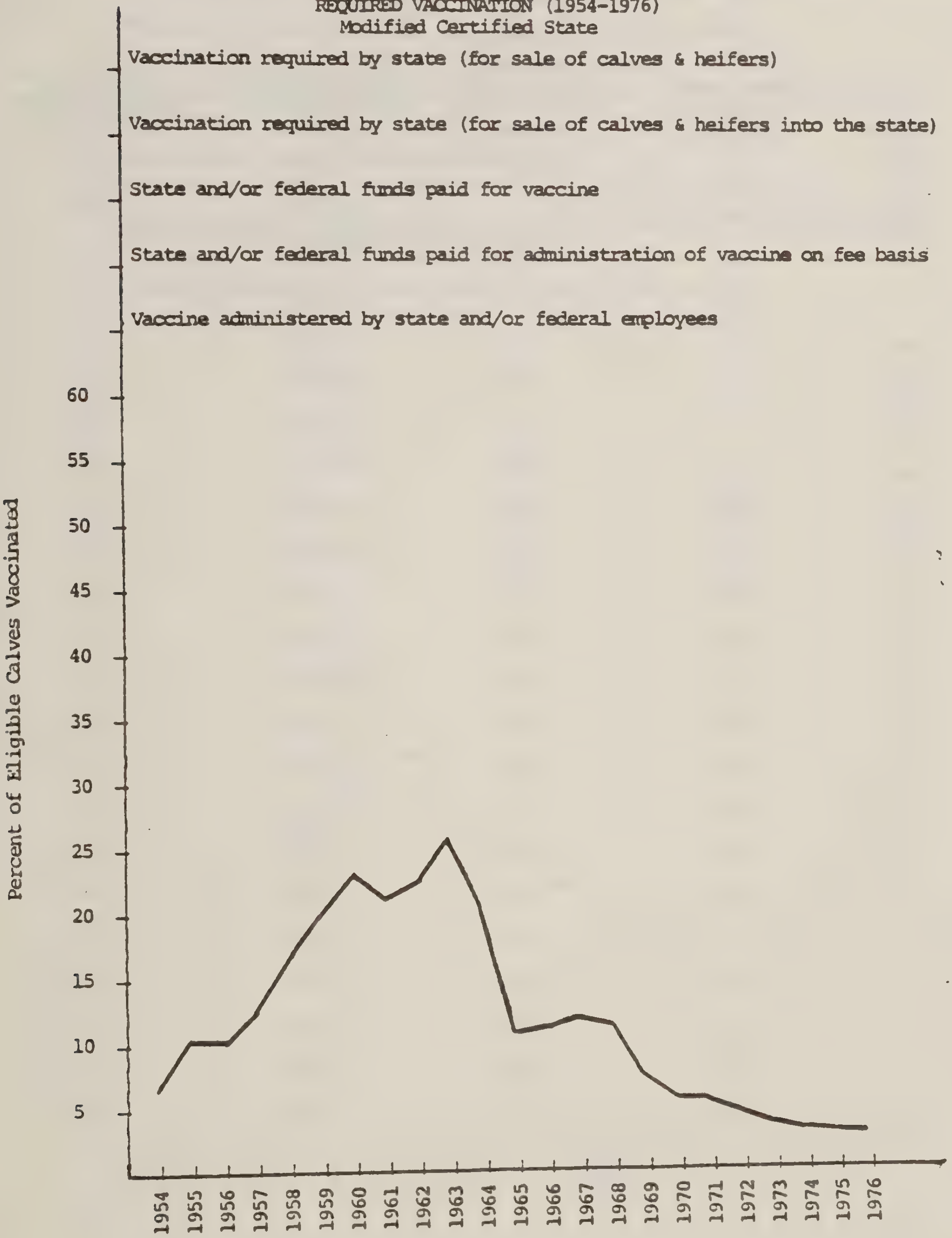


Table 1.72.2

LOUISIANA

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

Modified Certified State

Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or Those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	872	436	72,618	16.66
1955	966	483	86,754	17.96
1956	941	471	97,011	20.60
1957	936	468	101,829	21.76
1958	891	446	110,181	24.70
1959	839	420	104,135	24.79
1960	843	422	110,868	26.27
1961	870	435	128,411	29.52
1962	904	452	136,779	30.26
1963	901	451	138,496	30.71
1964	953	477	112,438	23.57
1965	948	474	103,118	21.75
1966	924	462	88,752	19.21
1967	900	450	93,175	20.71
1968	895	448	84,741	18.92
1969	899	450	71,047	15.79
1970	878	439	57,341	10.06
1971	894	447	45,121	10.09
1972	912	456	25,652	5.63
1973	870	435	13,111	3.01
1974	860	430	10,583	2.46
1975	890	445	10,592	2.38
1976	810	405	11,008	2.72

Figure 1.72.2

LOUISIANA

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

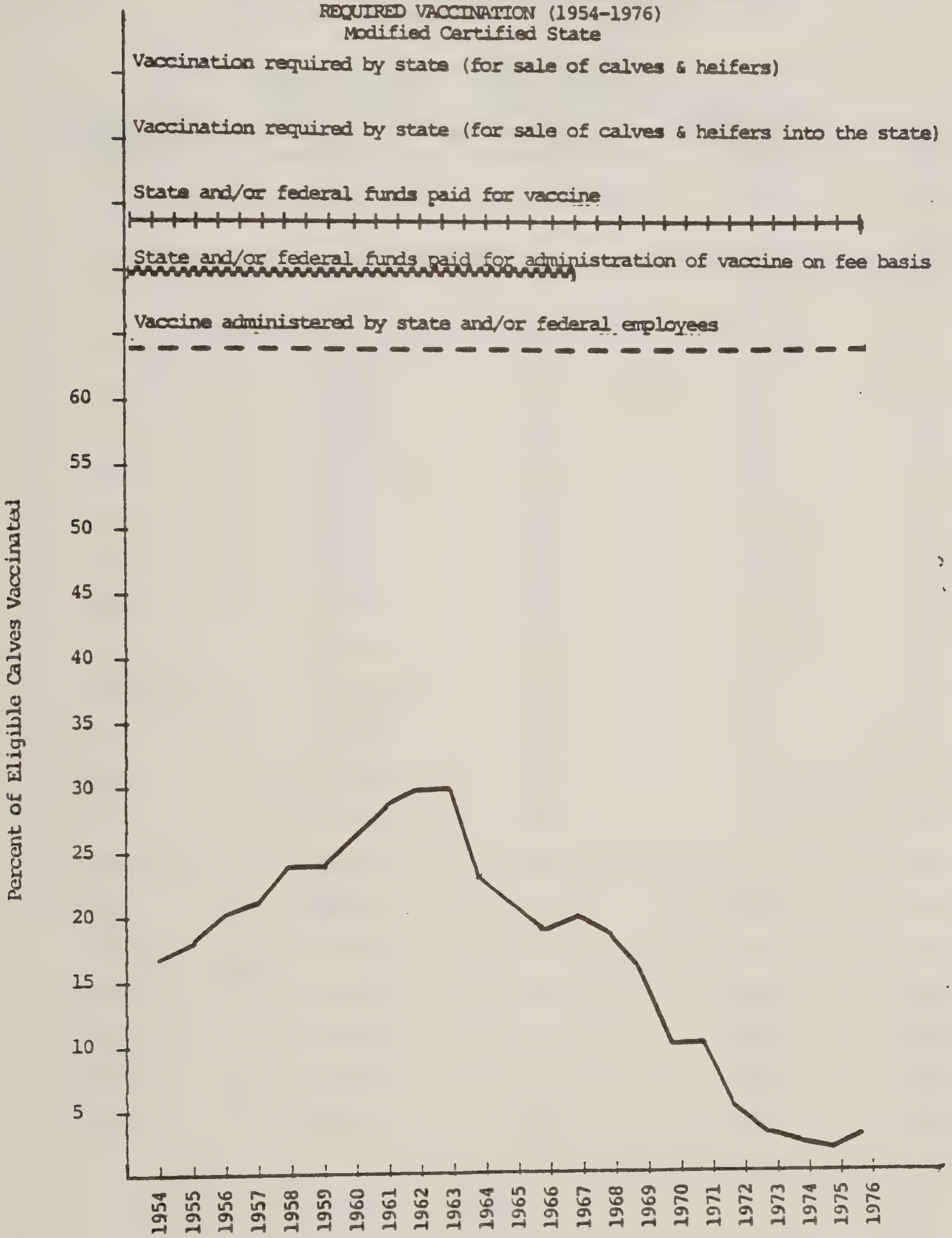


Table 1.41.2

MINNESOTA

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

Certified Free State

Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	1,674	837	138,703	16.57
1955	1,665	833	139,111	16.70
1956	1,679	840	143,842	17.12
1957	1,607	804	163,361	20.32
1958	1,585	793	185,141	23.35
1959	1,549	775	195,559	25.23
1960	1,568	784	203,055	25.90
1961	1,599	780	211,310	27.09
1962	1,618	809	212,571	26.28
1963	1,636	818	199,711	24.41
1964	1,684	842	202,078	24.00
1965	1,608	804	191,892	23.87
1966	1,527	764	182,562	23.90
1967	1,528	764	186,330	24.39
1968	1,495	748	179,303	23.97
1969	1,475	738	167,667	22.72
1970	1,473	737	170,644	23.15
1971	1,502	751	170,104	22.65
1972	1,472	736	164,051	22.29
1973	1,480	740	163,407	22.08
1974	1,525	763	154,363	20.23
1975	1,596	798	138,341	17.34
1976	1,450	725	127,089	17.53

Figure 1.41.2

MINNESOTA

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

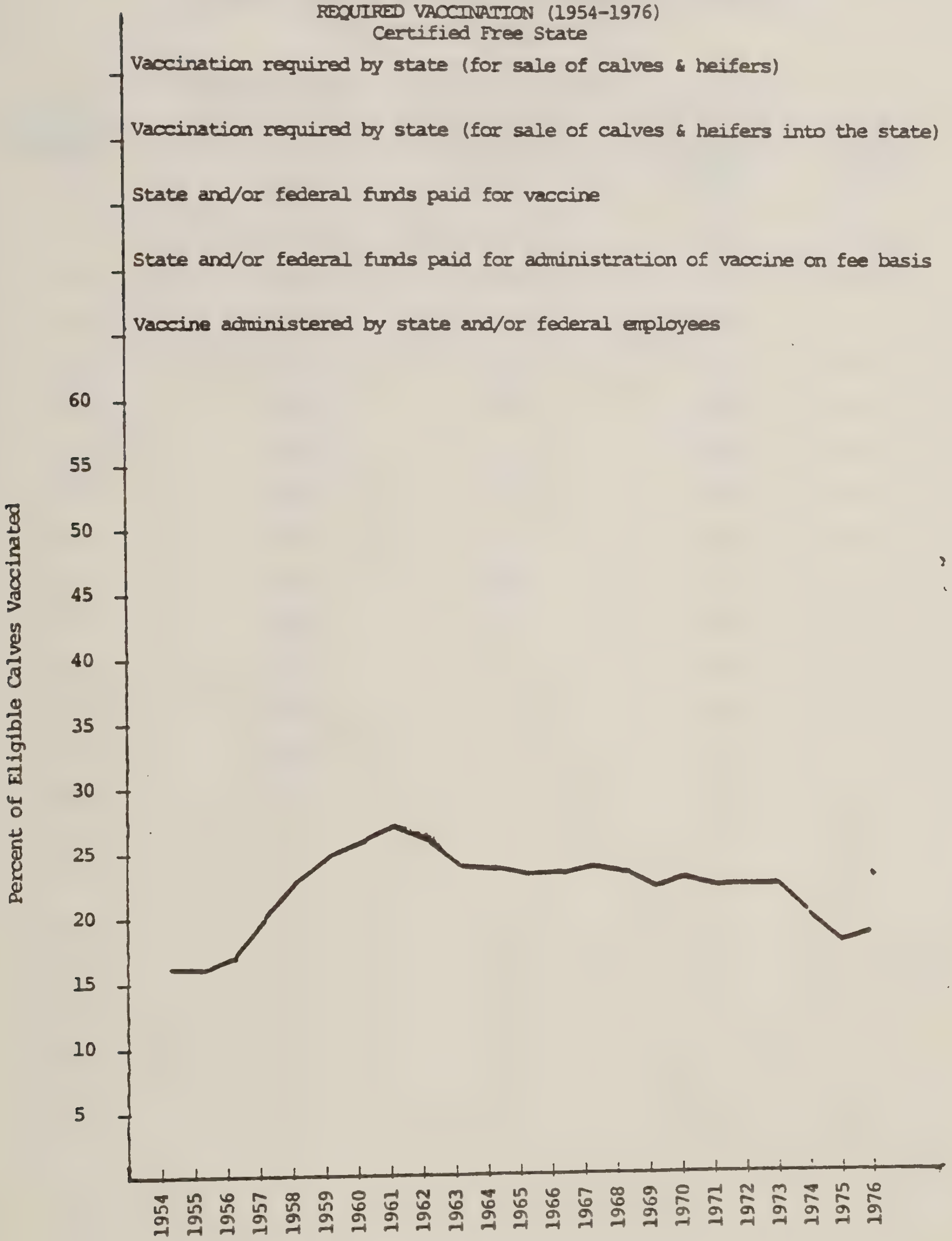


Table 1.43.2

MISSOURI

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

Modified Certified State

Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	1,835	918	82,065	8.94
1955	1,770	885	125,894	14.23
1956	1,705	853	195,689	22.94
1957	1,692	846	246,231	29.11
1958	1,605	803	306,766	38.20
1959	1,643	822	313,892	38.19
1960	1,654	827	308,392	37.29
1961	1,683	842	289,586	34.39
1962	1,740	870	307,026	35.29
1963	1,798	899	339,474	37.76
1964	1,895	948	355,901	37.54
1965	1,925	963	370,005	38.42
1966	1,925	963	362,600	37.65
1967	1,979	990	343,993	34.75
1968	2,031	1,016	296,908	29.22
1969	2,065	1,033	224,767	21.76
1970	2,139	1,070	76,398	7.14
1971	2,240	1,120	56,614	5.05
1972	2,375	1,188	50,321	4.24
1973	2,760	1,380	36,372	2.64
1974	2,840	1,420	21,122	1.49
1975	2,840	1,420	27,709	1.95
1976	2,700	1,350	23,970	1.78

Figure 1.43.2

MISSOURI

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

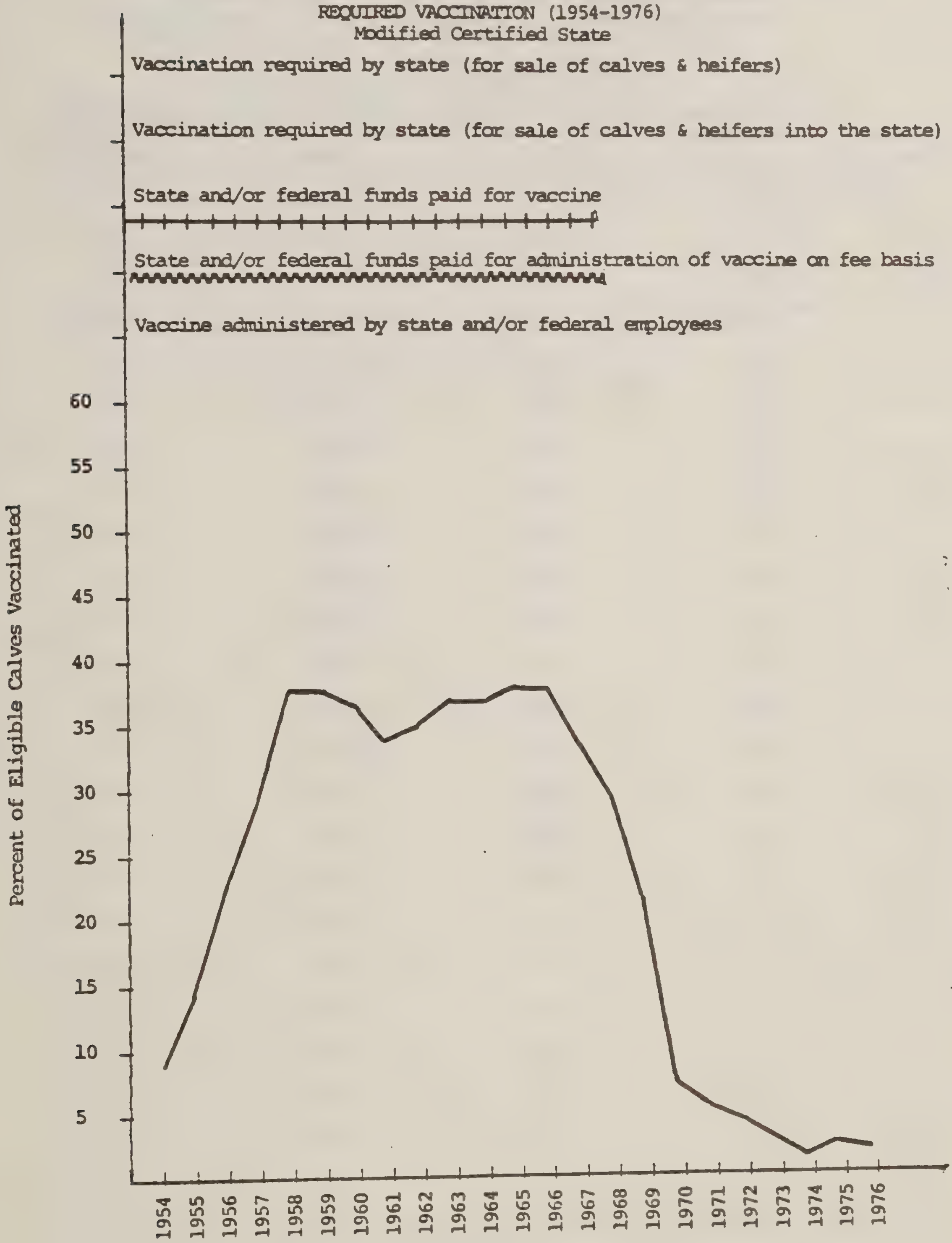


Table 1.21.2

NEW YORK

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

Certified Free State

Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	1,300	650	298,531	45.93
1955	1,328	664	266,656	40.16
1956	1,318	659	299,848	45.50
1957	1,280	640	256,410	40.06
1958	1,225	613	261,222	42.61
1959	1,190	595	283,181	47.59
1960	1,212	606	298,736	49.30
1961	1,204	602	316,249	52.53
1962	1,223	612	302,556	49.44
1963	1,183	592	267,020	45.10
1964	1,181	591	239,966	40.60
1965	1,147	574	241,322	42.04
1966	1,084	542	222,060	40.97
1967	1,051	526	219,807	41.79
1968	1,006	503	129,422	25.73
1969	1,006	503	201,673	40.09
1970	975	488	180,726	37.03
1971	967	484	159,187	32.89
1972	969	485	102,687	21.17
1973	959	480	46,024	9.59
1974	960	480	46,018	9.59
1975	975	488	53,094	10.88
1976	945	473	50,631	10.70

Figure 1.21.2

NEW YORK

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

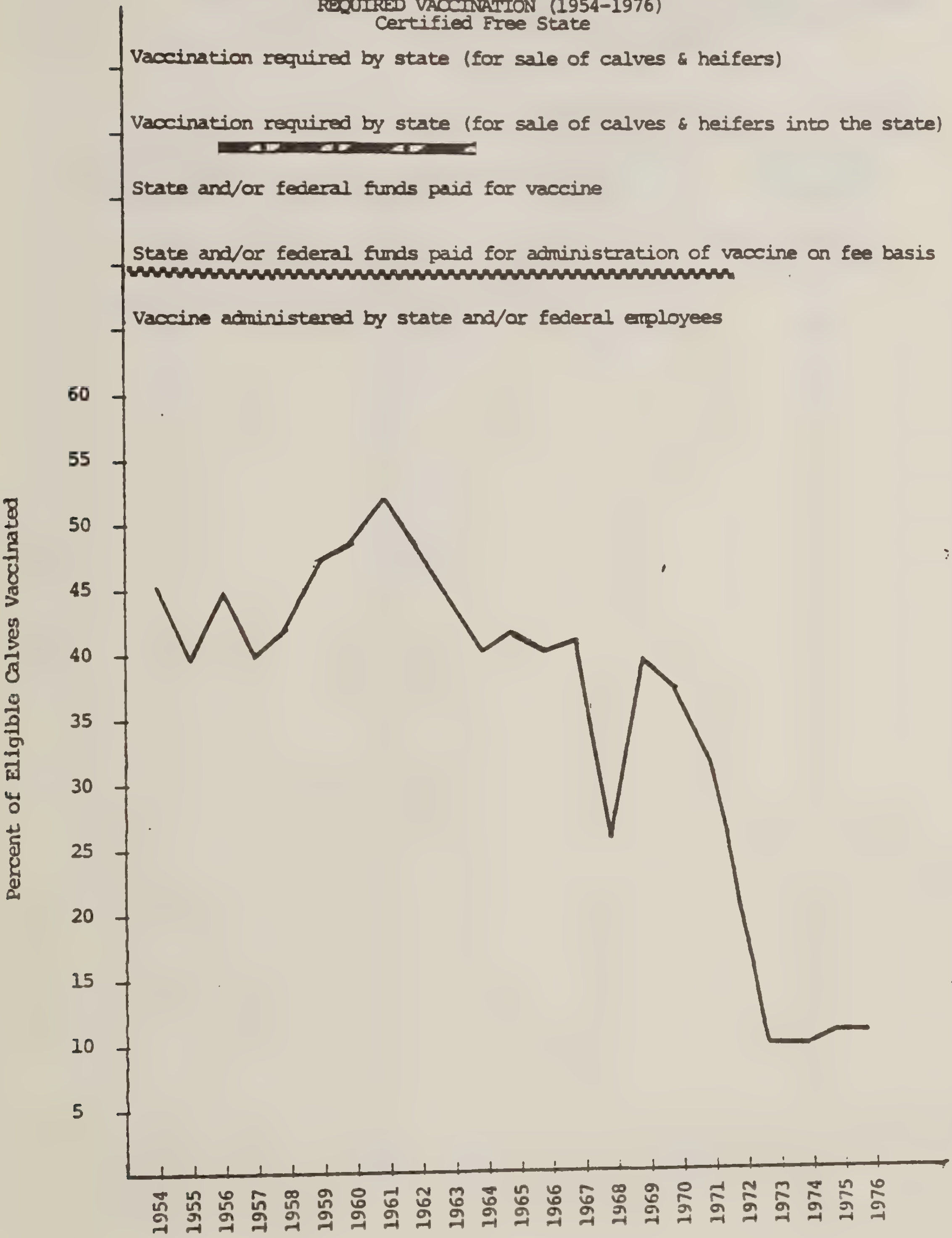


Table 1.55.2
NORTH CAROLINA
PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)
Certified Free State

Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	441	221	1,504	.68
1955	438	219	1,795	.82
1956	441	221	2,384	1.08
1957	430	215	3,000	1.40
1958	414	207	4,523	2.19
1959	410	205	7,245	3.53
1960	390	195	10,111	5.19
1961	398	199	14,870	7.47
1962	399	200	17,109	8.55
1963	396	198	21,447	10.83
1964	413	207	24,526	11.85
1965	418	209	28,617	13.69
1966	429	215	27,188	12.65
1967	435	218	23,520	10.79
1968	431	216	12,434	5.76
1969	445	223	5,128	2.30
1970	446	223	4,735	2.12
1971	459	230	2,774	1.21
1972	473	237	2,804	1.18
1973	490	245	2,517	1.03
1974	500	250	2,444	.98
1975	510	255	2,576	1.01
1976	490	245	2,253	.92

Figure 1.55.2

NORTH CAROLINA

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

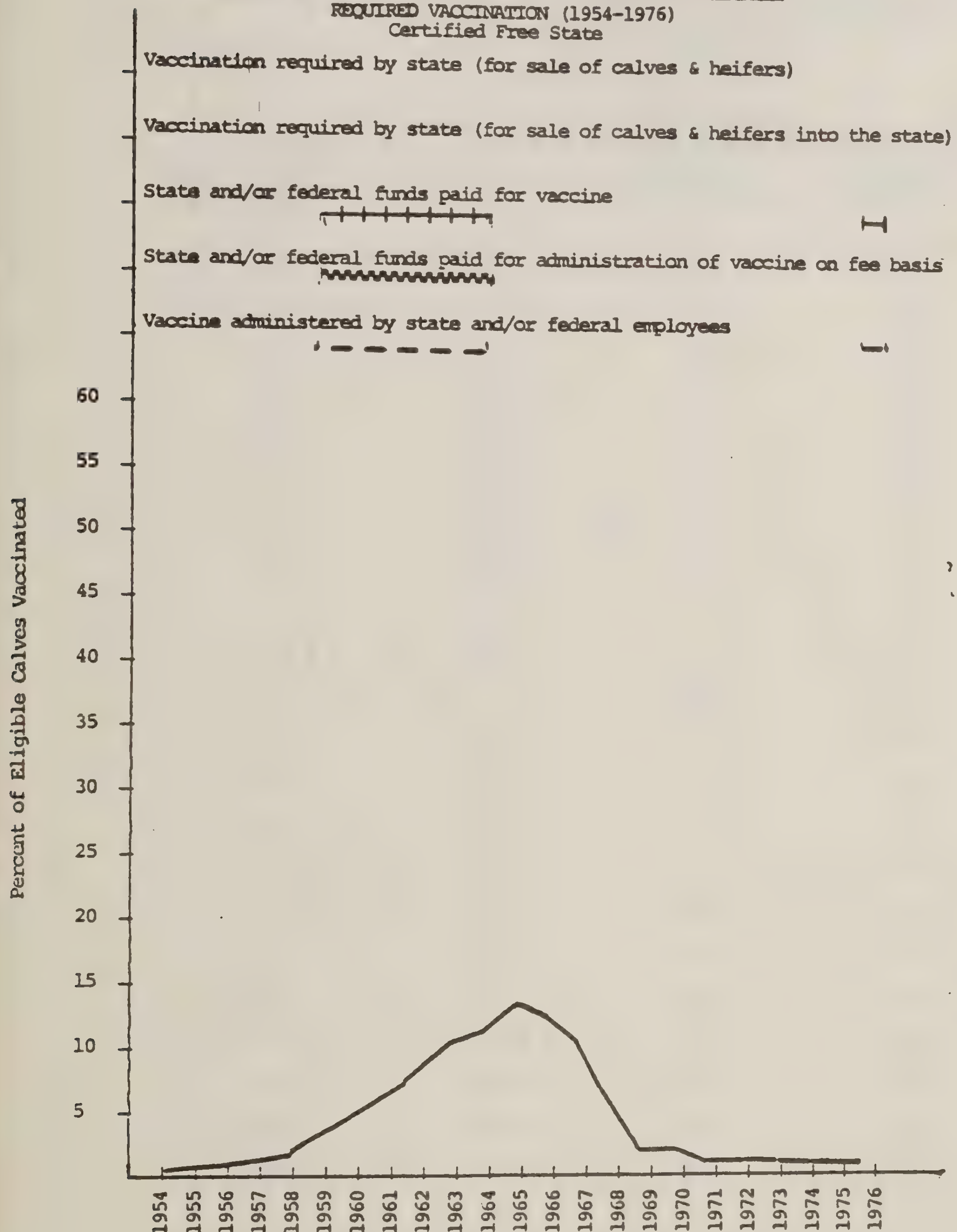


Table 1.45.2
NORTH DAKOTA
PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)
Certified Free State

Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	853	427	38,897	9.11
1955	886	443	60,026	13.55
1956	882	441	66,686	15.12
1957	866	433	102,482	23.67
1958	849	425	148,890	35.03
1959	866	433	165,591	38.24
1960	848	424	161,942	38.19
1961	886	443	211,224	47.68
1962	910	455	219,262	48.19
1963	963	482	260,319	54.01
1964	1,071	536	270,764	50.52
1965	1,081	541	254,549	47.05
1966	1,062	531	260,810	49.12
1967	1,064	532	279,111	52.46
1968	1,065	533	233,485	43.81
1969	1,069	535	186,878	34.93
1970	1,113	557	213,592	38.35
1971	1,148	574	231,307	40.30
1972	1,205	603	314,175	52.10
1973	1,264	632	317,626	50.26
1974	1,345	673	284,834	42.32
1975	1,300	650	220,259	33.89
1976	1,190	595	211,020	35.47

Figure 1.45.2

NORTH DAKOTA

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

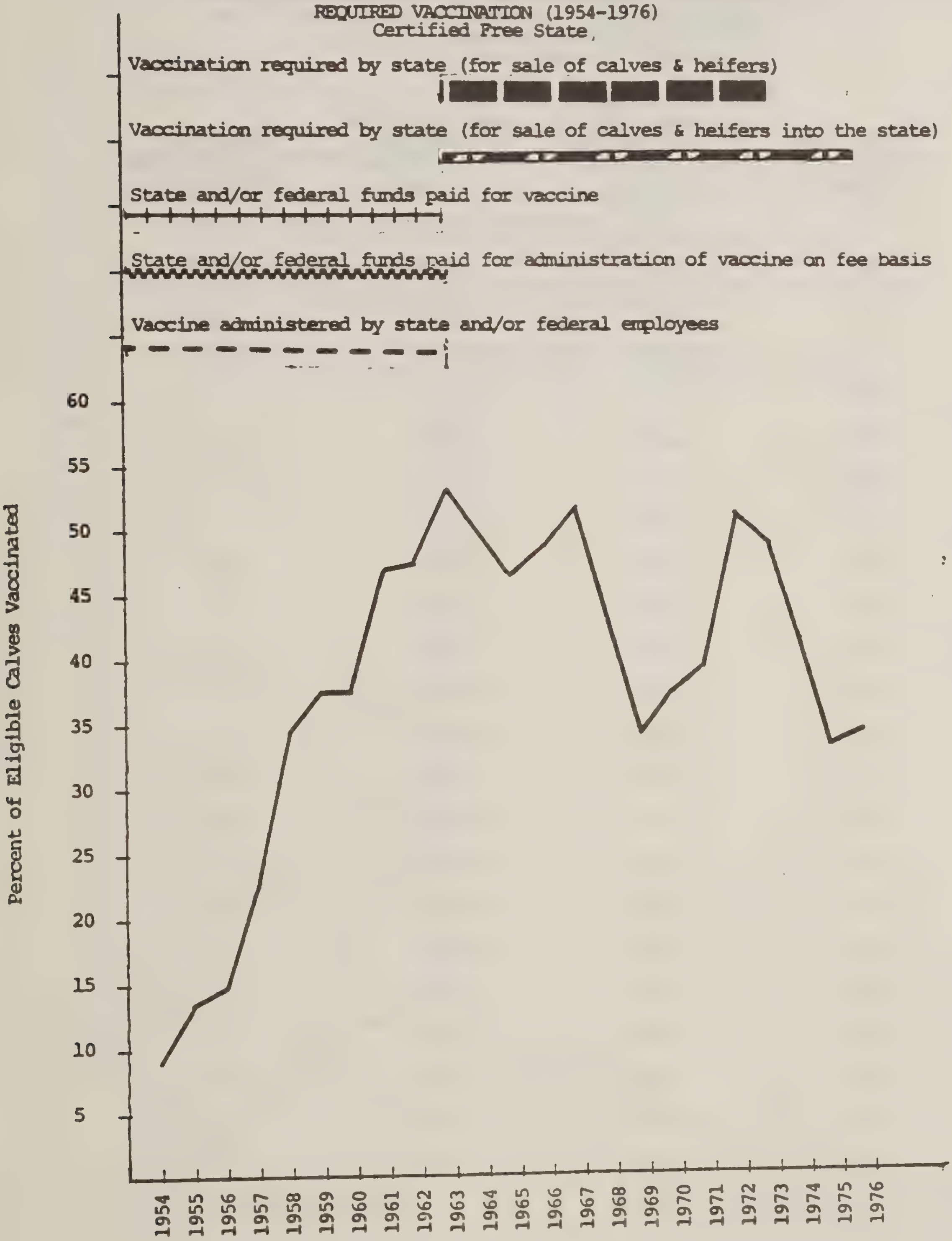


Table 1.74.2

TEXAS

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

Modified Certified State

Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	4,242	2,121	35,108	1.66
1955	4,200	2,100	67,590	3.22
1956	4,113	2,057	90,794	4.41
1957	3,734	1,867	130,813	7.01
1958	3,787	1,894	168,527	8.90
1959	3,894	1,947	225,246	11.57
1960	4,078	2,039	256,047	12.56
1961	4,137	2,069	295,572	14.29
1962	4,386	2,193	321,699	14.67
1963	4,517	2,259	432,543	19.15
1964	4,638	2,319	385,992	16.64
1965	4,667	2,334	309,516	13.26
1966	4,695	2,348	262,834	11.19
1967	4,876	2,438	312,018	12.80
1968	5,006	2,503	264,188	10.55
1969	5,290	2,645	209,331	7.91
1970	5,378	2,689	180,135	6.70
1971	5,286	2,643	164,172	6.21
1972	5,354	2,677	156,495	5.85
1973	5,900	2,950	153,111	5.19
1974	6,200	3,100	207,243	6.69
1975	6,000	3,000	157,926	5.26
1976	5,800	2,900	149,138	5.14

Figure 1.74.2

TEXAS

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

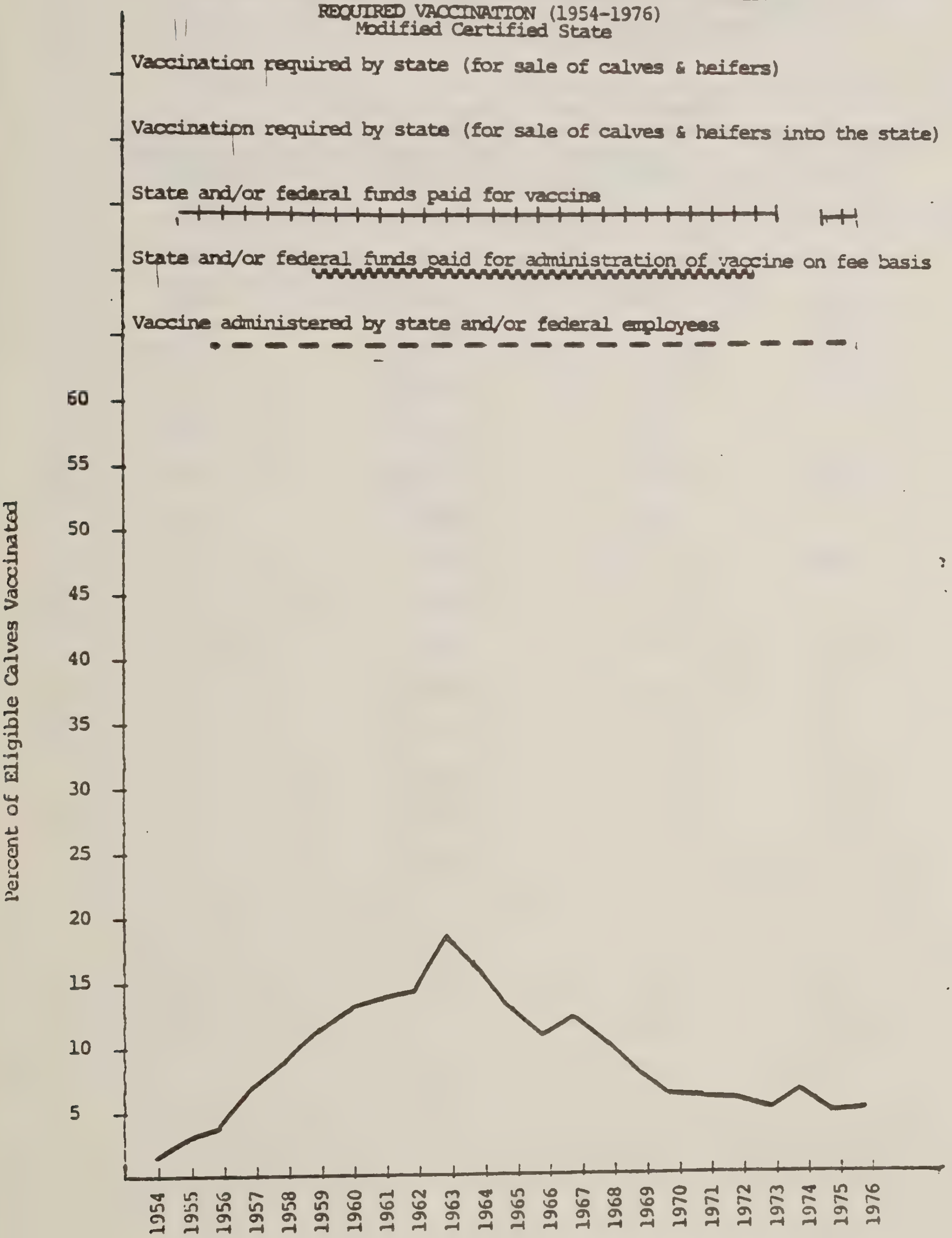


Table 1.35.2
WISCONSIN
PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)
Certified Free State

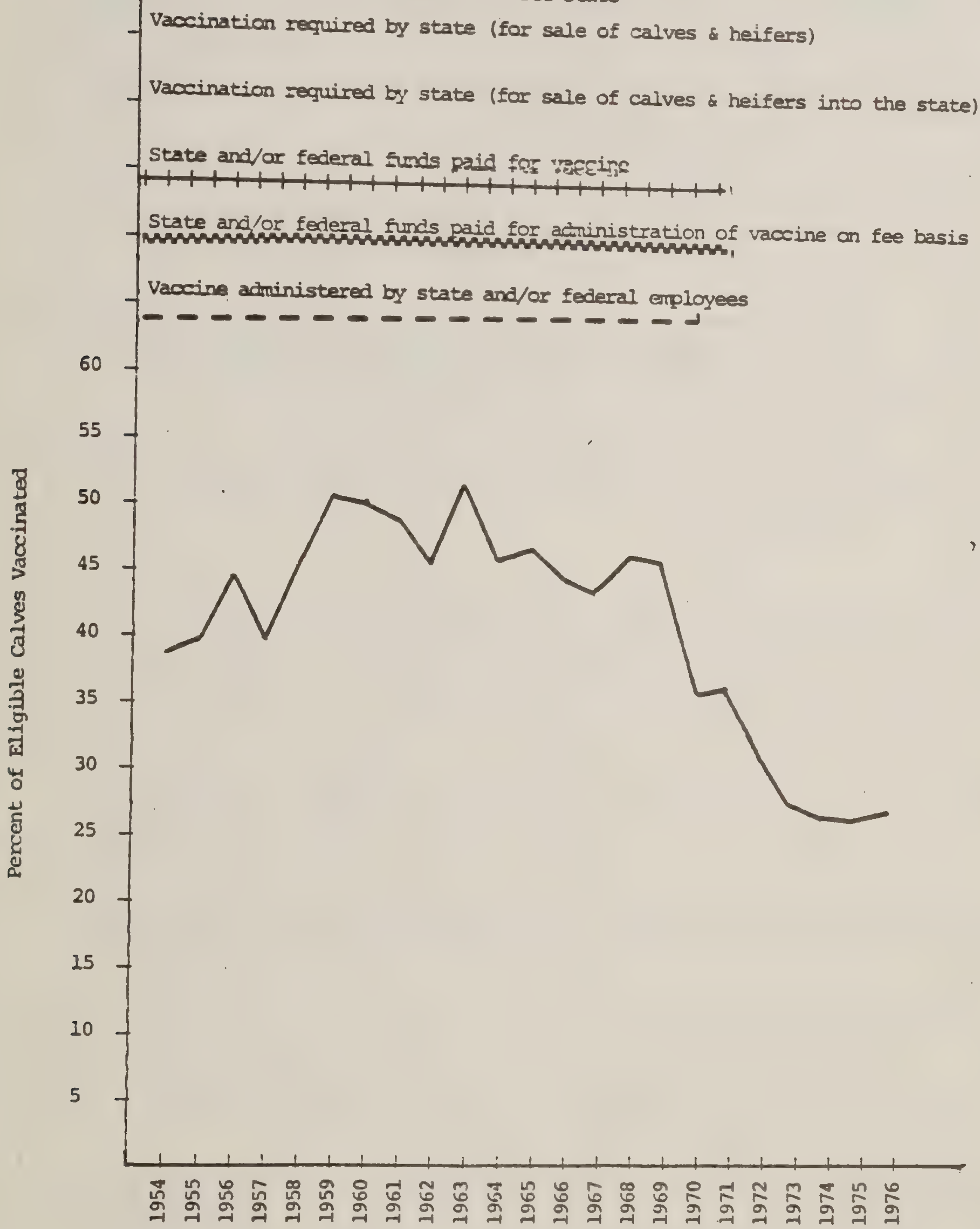
Year	Total Number Calves Born (Thous.)	Estimated Number of Female Calves or those Eligible for Vaccination (Thous.)	Number of Calves Vaccinated with Strain 19 Vaccine (Actual)	Percent of Eligible Calves Vaccinated
1954	2,464	1,232	485,092	39.37
1955	2,452	1,226	490,169	39.98
1956	2,435	1,218	548,010	44.99
1957	2,406	1,203	485,035	40.32
1958	2,314	1,157	529,425	45.76
1959	2,253	1,127	579,207	51.39
1960	2,272	1,136	575,104	50.63
1961	2,272	1,136	562,182	49.49
1962	2,309	1,155	528,458	45.75
1963	2,319	1,160	603,522	52.03
1964	2,313	1,157	533,774	46.13
1965	2,228	1,114	528,434	47.44
1966	2,180	1,090	491,082	45.05
1967	2,169	1,085	479,728	44.21
1968	2,143	1,072	502,588	46.88
1969	2,111	1,056	488,834	46.29
1970	2,080	1,040	375,433	36.10
1971	2,082	1,041	382,191	36.71
1972	2,080	1,040	328,556	31.59
1973	2,035	1,018	281,303	27.63
1974	2,050	1,025	280,314	27.35
1975	2,100	1,050	281,992	26.86
1976	2,065	1,033	281,122	27.21

Figure 1.35.2

WISCONSIN

PERCENT OF CALVES VACCINATED FOR BRUCELLOSIS IN RELATION TO VARIOUS INCENTIVE SCHEMES SUCH AS FREE VACCINATION OR LEGALLY REQUIRED VACCINATION (1954-1976)

Certified Free State



REFERENCES

1. Anonymous, (1977), Number of Herds of Cattle in Each State, prepared by Veterinary Services, Animal and Plant Health Inspection Service, USDA, Hyattsville, Maryland, and cooperating states.

2. Consumer Price Index for Urban Wage Earners and Clerical Workers, United States city average all items, series A, (1967 = 100), U.S. Department of Labor, Bureau of Labor Statistics, Washington, D.C., 20212 (1913 - to present).

3. Center for Disease Control: (1977) Brucellosis Surveillance, Annual Summary, Atlanta, Georgia 30333.

4. Aulaqi, N.A., Sundquist, W.B., (1977) Indemnification Under Animal Disease Control Programs with Special Emphasis on Foot-and-Mouth Disease, Department of Agricultural and Applied Economics, University of Minnesota, (Economic Report 77-2).

5. Anonymous, (1977), The Alternatives of Herd Depopulation, Evaluation Studies, Project 77035, Management Consulting Services, Agriculture Canada.

6. Hagan, W.A., Arnold, T.F., Clark, C.F., Knox, W.D., Price, F.E., (1956), Report of a Committee of Consultants Appointed by the United States Secretary of Agriculture to review the accelerated program of the federal government in cooperation with the states and territories, to control and eradicate bovine brucellosis in the United States, USDA, Washington, D.C.

7. Stuart, J.E., C.B. Bills, J.D.DeMattei, D.L. Mace, (1959), The Results of Eleven Years Vaccinating with Strain 19, Proceedings, 63rd Annual Meeting, U.S. Livestock Sanitary Association, 83-90.

8. Berman, David T., (1978), Personal Communication, Department of Veterinary Science, University of Wisconsin, Madison, Wisconsin.

9. Mingle, C.K., (1964), Proceedings 68th Annual Meeting, U.S. Livestock Sanitary Association, page 121.

10. Manthei, C.A., (1959), Summary of Controlled Research with Strain 19 Vaccine, Proceedings of the 63rd Annual Meeting, U.S. Livestock Sanitary Association, pages 91-97.

11. Berman, D.T., B.A. Beach, M.R. Irwin, (1952), Studies on Repeated Vaccination of Cattle with Brucella abortus Strain 19. III The Response of Vaccinated and Revaccinated Cattle to Conjunctival Exposure with a Virulent Strain of Brucella abortus During the Third Gestation Period, Am. J. Vet. Res., Vol. 13, 48:351-358.

12. Berman, D.T., P.H. Phillips, C.A. Brandly, (1952), The Failure of a Trace Mineral Supplemented Ration to Influence the Course of Bovine Brucellosis, J.A.V.M.A., p. 46-50.

13. Manthei, C.A., C.K. Mingle, R.W. Carter, (1951), Duration of Immunity to Brucellosis Induced in Cattle with Strain 19 Vaccine, Proceedings, Annual Meeting of the American Veterinary Medical Association, p. 128-142.

14. Manthei, C.A., C.K. Mingle and R.W. Carter, (1952), Comparison of Immunity and Agglutinin Response in Cattle Vaccinated with Brucella abortus Strain 19 by the Intradermal and Subcutaneous Methods, Proceedings of the 56th Annual Meeting, U.S. Livestock Sanitary Association, p. 100-114.

15. Berman, D.T. and M.R. Irwin, (1954), The Immunogenicity for Cattle of Brucella abortus Strain 19 and M Vaccine (Huddleson), J.A.V.M.A., Vol. 125, 932:401-405.

16. Goode, E.R., C.A. Manthei, T.E. Amerault, (1956), Further Studies on Duration of Immunity to Brucellosis Induced in Calf Vaccinated Cattle with Strain 19 Vaccine, Proceedings of the 60th Annual Meeting, U.S. Livestock Sanitary Association, p. 89-96.

17. Redman, D.R., B.L. Deyoe, N.B. King, (1967), Resistance of Cattle to Brucella abortus Following Vaccination at Two and Three Months of Age, J.A.V.M.A., Vol. 150, p. 403-407.

18. Lambert, G., T. E. Amerault, C.A. Manthei, E.R. Goode, (1961), Immunogenic Response of Calves Vaccinated at Different Ages with Brucella abortus Strain 19, Proceedings 65th Annual Meeting, U.S. Livestock Sanitary Association, p. 93-99.

19. Anderson, R.K., D.E. Pietz, C.J. Nelson, C.V. Kimberling, and D.F. Werring, (1963), Epidemiologic Studies of Bovine Brucellosis in Problem Herds in Minnesota, Proceedings U.S. Livestock Sanitary Association, p. 109-118.

20. Nelson, C.J., R.K. Anderson, C.V. Kimberling, D.E. Pietz, (1966), Epizootiologic Factors of Bovine Brucellosis: Comparative Bacteriologic Studies of Infected Herds, Am. J. Vet. Res., Vol. 27, 121.

21. Wixom, H.J. and L.C. Vanderwagen, (1965), Calfhood Vaccination: Its Relation to Brucellosis Eradication, Proceedings 69th Annual Meeting, U.S. Livestock Sanitary Association, p. 141-148.

22. Luchsinger, D.W., R.D. Angus, C.S. Gue, and R.K. Anderson, (1973), The Utilization of Brucella abortus Culturing and Biotyping Results in the Epizootiologic Investigation of Bovine Brucellosis, Proceedings 77th Annual Meeting, U.S. Livestock Sanitary Association, p. 85-89.

23. Safford, J.W., (1959), Montana Beef Cattle Brucellosis Vaccination Survey, 1952-1958, Proceedings 63rd Annual Meeting, U.S. Livestock Sanitary Association, p. 98-103.

24. Anonymous, (1959), USDA, ARS, Brucellosis Vaccination Survey, Beef Cattle - Montana (1952-1958) ARS - 91-12 (1-7).

25. Nicoletti, Paul, (1969), Further Evaluations of Serologic Test Procedures Used to Diagnose Brucellosis, Amer. J. Vet. Res., Vol. 30:10, p. 1811-1816.

26. Vanderwagen, L.C., (1978), Personal Communication, California Department of Food and Agriculture, Sacramento, California.

27. Agricultural Statistics Yearbooks, 1954-1976, USDA, U.S. Government Printing Office, Washington, D.C. 20402. (Source of beef and milk cow numbers and value of production).

28. Agricultural Statistics Yearbook, (1977), Tables 636 and 633, Prices Received by Farmers, Indexed Numbers by groups of commodities and parity ratio, United States, 1959-76, Meat Animals Index and Dairy Products Index, U.S. Government Printing Office, Washington, D.C. 20402, (Source of standardization for value of cattle and cattle production).

29. Census of Agriculture, (1959), Volume 2, General Report, Statistics by Subject, U.S. Department of Commerce, Bureau of Census, U.S. Government Printing Office, Washington, D.C. 20402. (Source of cattle population data).

30. U.S. Census of Agriculture, (1964), Volume 2, General Report, Chapter 2, Livestock, Poultry and Livestock and Poultry Products, U.S. Department of Commerce, Bureau of Census, U.S. Government Printing Office, Washington, D.C. 20402. (Source of cattle population data).

31. U.S. Census of Agriculture, (1969), General Report, Chapter 5, Livestock, Poultry, and Livestock and Poultry Products. (Source of cattle population data).

32. Census of Agriculture, (1974), Vol. 1, Part 51, United States, Summary and State Data, U.S. Department of Commerce, Bureau of Census, U.S. Government Printing Office, Washington, D.C. 20402. (Source of cattle population data).

33. Pietz, D.E., (1970), Brucellosis Epidemiology Course for Veterinarians, Biologic Reagent Section, Diagnostic Services, Veterinary Services, Animal and Plant Inspection Services, USDA, National Animal Disease Center, Ames, Iowa.

34. Nicoletti, Paul and Muraschi, T.F., (1966), Bacteriologic Evaluation of Serologic Test Procedures for the Diagnosis of Brucellosis in Problem Cattle Herds, Am. J. Vet. Res., Vol. 27, p. 689-694.

35. Nicoletti, Paul, (1967), Utilization of the Card Test in Brucellosis Eradication, J.A.V.M.A., Vol. 151, p. 1778-1783.

36. Crawford, Richard P., and Richard J. Hidalgo, (1977), Bovine Brucellosis, An International Symposium, Texas A & M University Press, College Station, Texas.

37. Elberg, Sanford, S., et al., (1977), Brucellosis Research: An Evaluation, A Report of the Subcommittee on Brucellosis Research, Committee on Animal Health, Board on Agriculture and Renewable Resources, National Research Council, National Academy of Sciences, Washington, D.C.

38. Alton, G.G., Lois M. Jones, and D.E. Pietz, (1975), Laboratory Techniques in Brucellosis, Second Edition, Published under the auspices of F.A.O. and W.H.O., World Health Organization, Monograph Series #55, Geneva, Switzerland.

39. Goode, E.R., T.E. Amerault and C.A. Manthei, (1975), Relationship of Sero-Agglutinin Titers to Other Infection in Strain 19 Vaccinated Cattle, Proceedings 58th Annual Meeting, U.S. Livestock Sanitary Association, p. 180-190.

40. Berry, W.T., (1978), Personal Communication, Report and Description of the Cattle Cycle, Western Farm Management Co., Denver, Colorado.

41. Meyer, Margaret E., (1964), The Epizootiology of Brucellosis and Its Relationship to the Identification of Brucella Organisms, Am. J. Vet. Res., Vol. 25:105, 553-557.

42. Roepke, M.H., Stiles, Jr., F.C. and Driver, F.C., (1957), A Summary on the Whey Plate Test for Brucellosis, Proceedings 61st Annual Meeting of the United States Livestock Sanitary Association.

43. Pietz, D.E., Anderson, R.K. and Werring, D.F., (1963), Effect of time and storage temperature of milk on the Brucella milk ring test, J. Amer. Vet. Med. Ass., 143:1202-1207.

44. Pietz, D.E., Anderson, R.K., Werring, D.F., Kenyon, A.J. and Jenness, R., (1967), A modified brucella ring test of cream, Am. J. Vet. Res., 28:39-49.

45. Roepke, M.H. and Stiles, F.C., (1970), Potential Efficiency of the Milk Ring Test for Detection of Brucellosis, Am. J. Vet. Res., 31:2145-2149.

46. Kimberling, C.V., Nelson, C.J., Vanderwagen, L.C., Pietz, D.E., (1965), Development of Tests Using 2 ml and 3 ml of Milk to Increase the Sensitivity of the Milk Ring Test, Unpublished paper presented at Conference of Veterinary Epidemiologists, University of Minnesota.

47. Vanderwagen, L.C., John Sharp, Margaret E. Meyer, (1978), A Retrospective Study on the Relationships of Vaccination Status of Reactor Animals, Management Practices at Calving and Herd Size to Eradicating Brucellosis in 79 Dairy Herds, Unpublished Report, California Department of Agriculture, Sacramento, California.

48. Roepke, M.H., J.M. Patterson, B.L. Deyoe, (1974), Brucella Ring Test Sensitivity of Individual and Pooled Bovine Milks with Various Preservatives, Am. J. Vet. Res., 35:115-118.

49. U.S. Department of Agriculture (1977) Code of Federal Regulations, Title 9: Animals and Animal Products

50. Pietz, D.E., Gilsdorf, M.J., (1978), A Preliminary Report on the Responses of Adult Cattle Inoculated Subcutaneously with Various Dosages of Strain 19 and Challenged with Brucella abortus Strain 2308, Presented at the Annual Meeting, American Veterinary Medical Association, Dallas, Texas, July, 1978.

51. Crawford, R.P., Heck, F.C., Williams, J.D., (1978), Experiences with Brucella abortus Strain 19 Vaccine in Adult Texas Cattle, Presented at the Annual Meeting, American Veterinary Medical Association, Dallas, Texas, July, 1978.

52. Ray, W., (1978), Brucellosis Vaccination of Adult Cattle -- First Year's Results in Infected Herds Using a Reduced Dose, Presented at the Annual Meeting, American Veterinary Medical Association, Dallas, Texas, July, 1978.

53. Nicoletti, P., Jones, L.M., Berman, D.T., (1978), Adult Vaccination with Standard and Reduced Dose of Strain 19 in a Large Infected Dairy Herd, Presented at the Annual Meeting, American Veterinary Medical Association, Dallas, Texas, July, 1978.

54. Deyoe, B.L., (1978), Reduced Dosage *Brucella abortus* Strain 19 Vaccination in Yearlings and Calves, Presented at the Annual Meeting, American Veterinary Medical Association, Dallas, Texas, July, 1978.

INDEX OF TABLES AND FIGURES